PUBLIC WORKS

City, County and State

BEAUTY AND NOVELTY IN PUBLIC WORK

Top left: Cornwall Bridge where route 4 meets route 7 in Connecticut; Top right: Excavating site of new water filtration plant at Hammond, Ind., financed with the aid of PWA; Lower left: Corrugated concrete laid out like spokes of a wheel makes base of the trickling filter for the new sewage treatment plant in Greenfield, Ind.; Lower right: Terracing of the Los Pasos Valley near Santa Paula, Calif., by the U. S. Dept. of the Interior to prevent soil erosion (photo courtesy International Harvester Co.).

JULY, 1935

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July
1935

PUBLIC WORKS

Vol. 66
No. 7

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

TABLE OF CONTENTS FOR JULY, 1935

TIMEWASTERS:

That Man in the Black Tie:

A number of earnest conners of Mr. Webster's popular textbook have written us regarding that last word in the solution given in the June issue. They say the word should be "importance" and we guess they are OK about it. Twisting "cremation" into "importance," by the simple addition of a "p" was too much for us. Congratulations to Messrs. Elder, Clark and Muller, or is it Miss Muller; and also several others whose letters arrived in my absence, and went into the file.

The Striking Clock:

Yep, 16½ seconds. From 1 to 12, there is 1½ seconds between each strike, but the last one doesn't count.

The Cemetery:

A. Lincoln White's cemetery comprised 10 acres, more or less, as the deeds say. Or, as Bob Clark says, "I come within one of Brer White's kinky hairs of making it 10 acres, and a 20° change in temperature would more than make the difference.

Did the Waiter Understand?

The 102004180 mentioned in the latest issue is translated to read, using some poetic freedom: "I ought to owe nothing for I ate nothing."

Come 7, Come 11:

If dollars and cents can be multiplied by dollars and cents to get dollars and cents, what four sums of money will multiply to $7.11 and also add to $7.11. This was contributed by *Alger Gildersleeve*, whom we are proud to claim as one of our very distant cousins. [To illustrate, $1.20 times $1.20 would be $1.44.] Go to it.

This Must Have Been a Model T:

A man drives from one city to another and home again. He travels uphill at the rate of 17 mph, and downhill at the rate of 41 mph. If the round trip consumes 29 hours, and the route contains no level stretches, how far apart are the two cities? From the irrepressible *RNC.*

A Revolver Problem:

A cube is revolved about a diagonal. Find the volume generated. Contributed by *John Bevan.*

W. A. H.

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A. PRESCOTT FOLWELL, *Editor* W. A. HARDENBERGH, *Asso. Editor*

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 66 | *July, 1935* | No. 7

Roadwork for Unemployment Relief

Some of the methods of low-cost road construction which can be utilized in unemployment relief.

AS this is written (July 1), it appears that projects for unemployment relief will be restricted to those which will provide a year's work for one man for every $1200 to $1400 expended. Without agreeing with this ruling, but pending the result of efforts to have it modified, there are presented here data on methods of good road construction which, with careful management, can generally be held within the prescribed cost.

One effect of the ruling will undoubtedly be to require the engineer to plan his projects more carefully. Since *every* project will be judged on the above basis, engineers should generally try to prepare complete projects, involving all steps in the work. In most cases it will be found that a project involving grading, improvement in alinement, drainage, bank sloping and surfacing can be made to comply with the expenditure allotment, whereas a project for surfacing alone cannot always be made to do so.

Work Relief in a Rural County

By Olney Borden

Project Engineer, Sullivan County, EWB

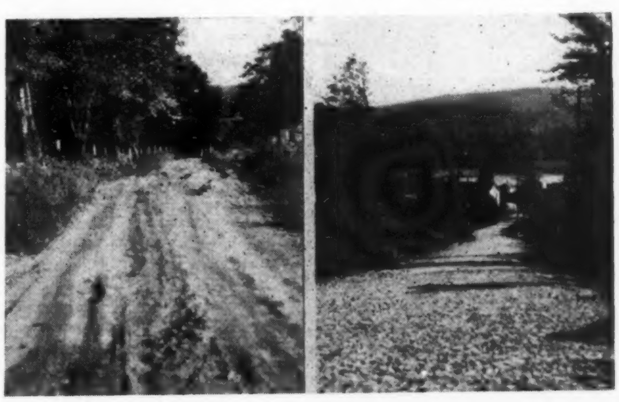
IN a rural county which includes no cities and only two villages of as much as 3,000 population, highway construction has been found to be highly efficient in putting men to work quickly, and in keeping them at work, even through bad weather periods. Moreover, the work has been highly beneficial to the rural sections in providing improved roads in areas hitherto served only by very poor dirt roads. In Sullivan County, New York, road work was carried on all through the very severe winter of 1933-34, under the CWA.

This work was continued in the spring of 1934 under the ERA, whereby local communities paid 25 per cent of the labor and the TERA 75 per cent. Materials and equipment were furnished in the same proportions, but in limited amounts. The work has been carried on under the Township basis, whereby each town takes care of its certified relief cases.

Under these bases of work, during the year ending April 1, 1935, 50.14 miles of broken stone base road were built in the county, and 30.75 miles were improved by cutting back turns, widening, installing corrugated iron culverts, and putting on shale or gravel top. It has been found that by doing the rough grading and shoulder work in the early fall, the stone base (mostly hammer broken) could be put in during the winter months at a price comparable with summer work.

Based on work that has been done with relief labor at 40c per hour; dump trucks, 1½-yard, with driver, $1.25 per hour; tractor and grader, with 1 operator, $2 per hour; roller and operator, $2 per hour, unit costs have averaged, on our work:

Hammer broken stone base, in place, per cu. yard	$1.70
Rough grading, per lineal foot of road	.08
Ditch and shoulder improvement, per lineal foot of road	.10
Rolling base and top, per lineal foot of road	.04
Shale or gravel top in place, per cubic yard	1.00



Left: The unimproved road generally found in the rural sections of Sullivan County. Right: An improved road; foreground not surfaced.

The average cost of the above type of road, 15 feet wide, with 6 inches of stone and a 2-inch gravel top has been $3,600 per mile. The added cost for a bituminous macadam top has been about 20%.

Regarding the present regulation that each project must provide one year's work for one man for each $1,400, it is believed that this can be done. Herewith are shown data on a partly completed road as of May 23, 1935.

Costs on Partly Completed Highway Project, Sullivan County E. W. B.

Item	*% Comp.*	*Unit*	*No. of Units*	*Actual Unit Costs Labor*	*Equip.*	*Mat'l.*	*Total*	*Expenditures Labor*	*Equip.*	*Mat'l.*	*Total*
Broken Stone Base......	75	c.y.	3,551	1.00	.40	.10	1.50	3,551.00	1,420.40	355.10	5,326.50
Grading & Ditching.....	56	l.f.	11,985	.07	.02	—	0.09	838.95	239.70	—	1,078.65
Top-Course (Shale)	40	c.y.	871	.80	.40	.10	1.30	696.80	348.40	87.10	1,132.30
Culverts (12").........	77	l.f.	230	.60	—	1.00	1.60	138.00	—	230.00	368.00
Rolling (Base & Top) ...	60	l.f.	13,015	—	.02	—	0.02	—	260.30	—	260.30
Blasting Rock	100	c.y.	60	1.70	.80	.50	3.00	102.00	48.00	30.00	180.00
Supervision	—	—	—	—	—	—	—	648.00	—	—	648.00
Totals	—	—	—	—	—	—	—	5,974.75	2,316.80	702.20	8,993.75

On the basis of the actual costs on this job, on which 14,937 man hours of labor have been employed, the mathematics are as follows: 14,937 man hours, at 8 hours per day, and 300 days per year, provide 6.224 man-years of labor, and the allotment on the $1400 basis would be $8,713.60. The actual cost to date has been $8,993.75. With the new set-up contemplated costs can be kept within the limit set. It will be noted that, on the above basis, a man-year of labor is charged as 300 8-hour days at 40c per hour, or a total of $960.

Judging from the results obtained during the past year with work relief in Sullivan County, we feel that the work is being done efficiently, and in most cases as economically as it was done in the past with regular town employees. There is a measure of satisfaction in that this work, of real benefit to the community through the extension of good roads, has been so efficient and economical. Highway work has not been the only type of work carried on. Other of our projects will be described in an early issue of this magazine. From our experiences with all of these we feel that the work can be made to approximate in cost contract construction.

Unit costs of construction on stone base, gravel top construction, and on bituminous macadam, are shown in the following tables:

The estimate on Project 48-Bb-71 was: For labor, $3,050.00; for Equipment, $1,668.80; for material, $1,289.00, a total of $6,007.80. The actual costs, which are given in the table, are seen to approximate very closely to the estimate for both labor and equipment.

A similar estimate prepared for a project in the town of Mamakating provides for the following on 5.80 miles of gravel and shale top road, on which improvement of shoulders and ditches, widening, and the installation of 600 lineal feet of corrugated iron culverts will be required: Labor cost: $6,464.25; Equipment cost, $2,562.73; Material cost, $1,203.70, a total of $10,230.68.

The work in Sullivan County has not been confined wholly to highway work, however. There have been a number of projects including sewerage, drainage and water line construction. Much of this type of work has been done directly by the villages in the county. One of the finest projects to date has involved the reconstruction of sewers. This will be described in an early issue of this magazine. The work, including some very deep and difficult trenching in an extremely constricted working space, was carried by force account at costs surprisingly low.

Sullivan County E. W. B.

Project 48-Bb-70—May 17, 1935: 1.20 Mi. Town Road with Stone Base and Gravel Top.

Item	*Unit*	*Quantity*	*Labor*	*Mat'l.*	*Equipment*	*Total Unit*	*Labor*	*Material*	*Equipment*	*Total Cost*
Broken Stone Base	c.y.	1,760	.90	.10	.30*	1.30	$1,584.00	$176.00	$528.00	$2,288.00
Gravel Top Course	c.y.	704	.25	.10	.40*	.75	176.00	70.40	281.60	528.00
Ditches & Shoulders	l.f.	6,336	.07	—	.02**	.09	443.52	—	126.72	570.24
Rough Grading	l.f.	6,336	.03	—	.03**	.06	190.08	—	190.08	380.16
Corr. Culverts	l.f.	22	.75	1.00	—	1.75	16.50	22.00	—	38.50
Rolling Base	l.f.	6,336	—	—	.02	.02	—	—	126.72	126.72
Totals							$2,410.10	$268.40	$1,253.12	$3,931.62
Supervision: 1 Foreman, 51 days at $4.80.................................. ..										244.80
Total Cost										$4,176.42

Length of road, 6,336 feet; Average width, 15 feet; Thickness, 6 inches. Cost per mile, $3,480.35. Average gang, 15 men; labor rate 40c per hour. * Dump Trucks; ** Power Grader.

Project 48-Bb-71—Completed May 30, 1935. 0.875 Mi. Town Road, Stone Base, Bituminous Gravel Top.

Item	*Unit*	*Quantity*	*Labor*	*Mat'l.*	*Equipment*	*Total Unit*	*Labor*	*Material*	*Equipment*	*Total Cost*
Broken Stone Base	c.y.	1,400	1.15	.10	.30*	1.55	$1,610.00	$ 140.00	$ 420.00	$2,170.00
Sub-Base Stone	c.y.	710	.60	.10	.30*	1.00	426.00	71.00	213.00	710.00
Rough Grading	l.f.	4,620	.03	—	.03**	.06	138.60	—	138.60	277.20
Ditches & Shoulders	l.f.	4,620	.06	—	.02**	.08	277.20	—	92.40	369.60
Rolling Base & Top	l.f.	4,620	—	—	.07	.07	—	—	323.40	323.40
Corr. Culverts	l.f.	128	1.33	1.53	—	2.86	170.50	196.00	—	366.50
Top Course:										
Bituminous Mater.	gal.	6,000	—	.125	—	.125	—	750.00	—	750.00
Sand	c.y.	200	.60	.75	.50*	1.85	123.60	154.50	103.00	381.10
Gravel	c.y.	106	.60	1.65	.60*	2.85	63.60	174.90	63.60	302.10
Blasting Large Rock	c.y.	60	.60	.70	1.00***	2.30	36.00	42.00	60.00	138.00
Totals							$2,845.50	$1,528.40	$1,414.00	$5,787.90
Supervision, 1 foreman, 44 days at $4.50................................... .										198.00
Total Cost										$5,985.90

Length of road, 4,620 feet; width, 14 feet; thickness, 7 inches; Cost per mile, $6,841.03. * Dump Trucks; ** Power Grader; *** Air Compressor.

Widening and Improving An Old Highway

Old Brick Road Widened Four Feet, Crown Reduced, and New Riding Surface Constructed

WASHINGTON COUNTY, PA., had several miles of brick road which had given excellent service over many years; but the width was only 14 feet, too little for modern conditions, and the crown was as much as 8 to 10 inches. It was decided to widen, reduce the crown and resurface.

Widening and Placing Wedge Course

The pictures at the top show how the road was widened; a trench 2 feet wide was dug on either side of the road, leaving the concrete header in place. This was filled with slag macadam, which was primed with ½ gallon of Tarmac P per square yard. A wedge course was then built to reduce the crown. The picture at the right shows the wedge course in place, and a truck dumping slag for the mixed-in-place surface. The wedge course consisted of about 400 tons per mile of slag, treated with Tarmac P, and bladed. This was spread along the edges and rolled.

Construction of Surface and Seal Coat

A week or ten days later, the mixed-in-place surface was constructed. This consisted of 800 tons of slag per mile, spread in the center of the road, as shown at the right, from trucks with attached spreaders. After an application of ½ gallon of Tarmac A at 190°, the aggregate was mixed with a blade grader. Another application of ½ gallon followed, with further mixing. The coated aggregate was then bladed to one side of the road, the old brick surface given a prime coat of ¼ gallon per square yard of Tarmac, and the mix bladed back over the prime coat and finally into a windrow in the center of the road.

The material was then spread uniformly over the surface with a grader, and rolled the following day. The operations of applying tar, blading and rolling are shown. Following this, about 10 pounds per square yard of ⅛ to ⅜-inch chips were spread over the surface and rolled in, after which the road was opened to traffic. About two weeks later, a seal coat of ¼ gallon of Tarmac A was applied, with 15 pounds per square yard of ⅛ to ⅜-inch stone chips, and rolled. The resulting finished road, broad, inviting, and smooth-riding, is shown at the bottom.

Using Powdered Activated Carbon in Sewage Treatment

ACTIVATED carbon is by no means a new material in the field for the removal and control of odors. However, its application to sewage treatment is a comparatively recent development and a great deal of study is being given to the subject at the present time.

The mechanics of the application of powered activated carbon are very simple and the benefits from its use are interesting to sewage treatment operators and chemists. The ideal method of application is by means of a dry-feed machine equipped with a water ejector which sucks in the carbon and delivers the suspension to the point of application. The volume of water involved is of no importance. It is merely the means of insuring effective distribution of carbon through the sewage to be treated, as the powdered carbon mixes readily to form an effective suspension.

At this time the most effective point of application of powdered carbon seems to be to the sewage in the trunk line flowing to the treatment plant, where the carbon becomes intimately mixed with the incoming sewage and settles out in the primary settling tanks to a large extent, part of the fine carbon flowing out with the settled effluent to the trickling filter plant. The sludge-carbon mixture deposited in the primary settling chamber passes on to the digestion units, where the decomposition reaction goes on to more complete digestion with a resulting increase in gas production. It is found that application of carbon at this point is effective in both odor control and reduction of scum formation. The point of application for increasing sludge digestion is preferable in the form of a split treatment during the first week of application, half of the carbon being added directly to the sludge in the digestion tank and the remainder to the raw sewage entering the plant.

The dosages required for improving odor conditions, reduction of scum, and increasing the rate of digestion vary with the age and condition of the sludge, to a great extent, but an average dosage is between 40 and 50 pounds of carbon, (either applied to the incoming sewage before the first sedimentation tank, or directly to the digester) per million gallons of sewage flow per day. This dosage may be applied as already stated, before the bar screens, if excessive scum is formed on the primary sedimentation tank, or if there are severe odor conditions. Otherwise, in case it is required to improve digestion of the sludge, the dosage may be applied directly with the sludge pumped to the digestion tank, or directly through the sludge blanket.

Concerning experiments at the *Fairport, N. Y.*, sewage plant, Cary reported: The experiments on sludge in the secondary tanks carried on in Fairport are meeting with marked success. The sludge has stayed down one month during the addition of 5 lbs. of carbon per day to 300,000 gallons of sewage. The sludge had no disagreeable odor when removed from the tank.

At the *Garden City, N. Y.*, sewage disposal plant, Rogers reports the use of carbon during the winter months improves digestion. The addition of 40 lbs. (per million gallons) carbon to the raw sewage increased gas production with an accelerated liquefaction of the sludge, resulting in more efficient digestion. The carbon was introduced in solution directly into the sludge digestion tank to get a thorough distribution of the carbon particles in sludge. As soon as seeding was accomplished, the carbon was then added to the raw sewage at a point about a mile above the treatment plant. It is interesting to notice that gas formation started three days after the first application of the carbon direct to the digestion tank.

The most advantageous point to use activated carbon in the Garden City plant appears to be directly to the sewage sludge in the digestion tank. When added to the raw sewage before sedimentation, some of the carbon passes along with the effluent, together with the grease, forming a non-filtering layer on the sand.

At the *East Rochester, N. Y.*, sewage plant, a test of an average of 36 days, conducted during the fall of 1934, indicated considerable improvement in digestion of sludge. A summary of the report is as follows:

"1. The rate of gas production increased 98% with Nuchar during an average of 36 days.
2. (a) Solids content of the sludge appears to be high.
(b) A compacting of the sludge may be effected by the Nuchar.
3. The supernatant liquor is clarified, showing very little suspended matter, and very little scum at the surface.
4. No change is seen on the removal of suspended solids in the tank.
5. The Nuchar may possibly increase the efficiency of the tank in B.O.D. reduction."

At the *Newark, N. Y.*, activated sludge plant, Smith found that the addition of 35 lbs. per million gallons, of carbon to the raw sewage reduced the hydrogen sulphide odor, and greatly reduced the scum formation in the primary settling tank. Comparatively little grease or floating solids has been noticed since the carbon treatment was begun. There was a noticeable decrease in quantity of grease separating in the aeration channels and the gas in the digester seems to be "dryer," assumed by the greatly reduced amount of water removed from the drip pipes. The quality of the gas seems to be improved, as the gas engine requires 100 cubic feet of gas less per hour, than before the application of carbon. This is approximately 25% reduction of gas required for operation of the gas engine.

In reporting these results, an attempt is made to point out that activated carbon is now creating considerable interest in the sewage treatment field as an aid in digestion and for the control of odors. The economies of its application are a direct result of improved operating conditions.

The above plant-scale work is the outcome of the initial work done by Dr. Rudolfs at the New Jersey Experiment Station and whose active interest in carbon for sewage treatment is much appreciated.

We wish also to acknowledge the cooperation of William A. Ryan of Rochester, F. Arthur Cary of Fairport, Roland MacDonald, and Harold Deming, both of East Rochester, A. H. Rogers of Garden City, L. H. Wright, and T. J. Smith, both of Newark, and Charles C. Agar, N. Y. S. Dept. of Health.

Considerable research work is being carried out at this time at the Ithaca, N. Y., plant under the supervision of Prof. C. L. Walker, of Cornell University.

Developing a Water Supply for the Tygart Valley Homesteads

By Edmond T. Roetman
Engineer, Tygart Valley Homesteads

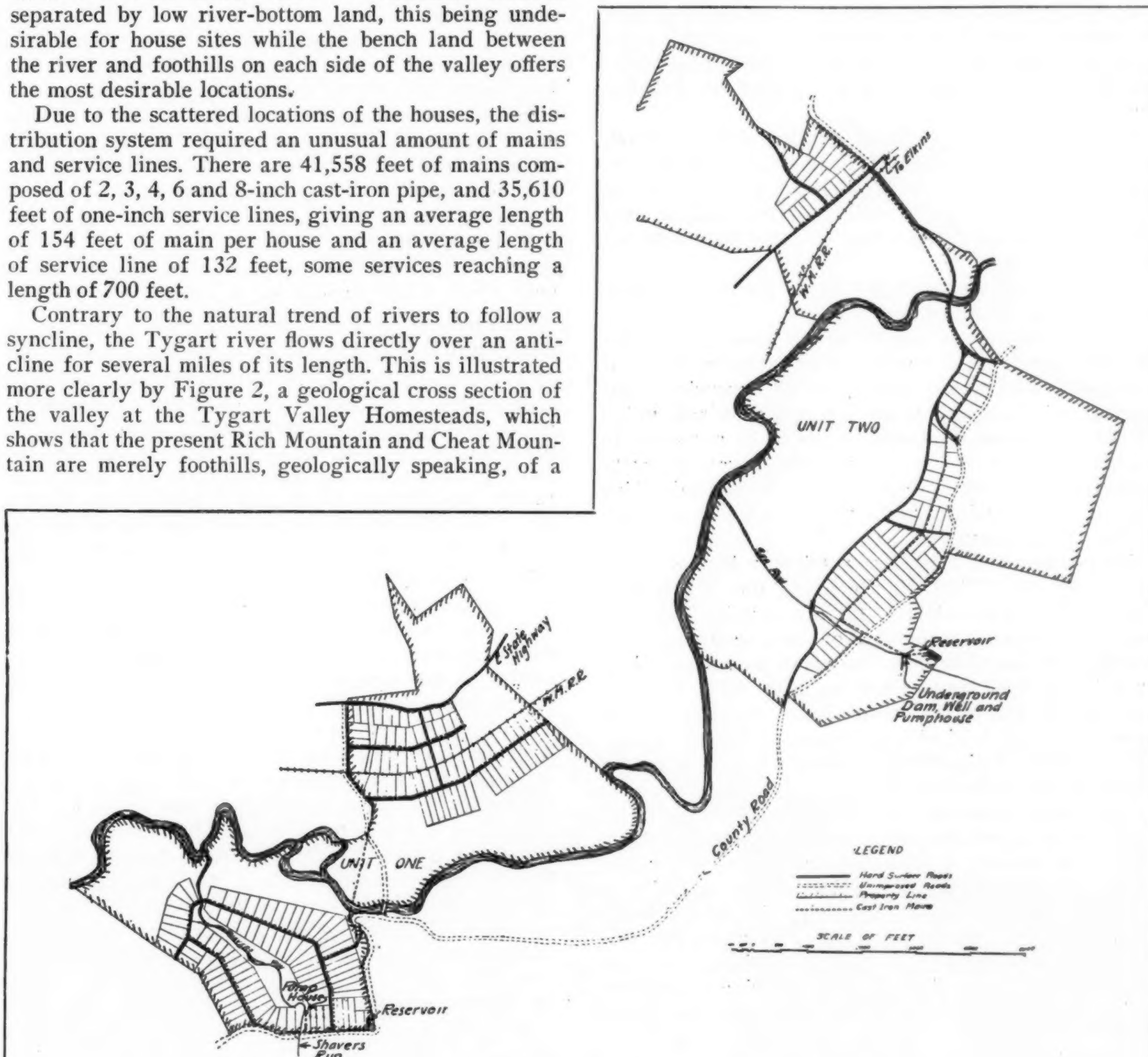
THE Tygart Valley Homesteads, one of the Subsistence Homesteads being constructed by the government, is located in the fertile and beautiful valley of the Tygart river ten miles south of the city of Elkins, West Virginia.

The relative positions of the many parcels of land which go to make up the homesteads had an important bearing on the design of the water system. The land is divided into two tracts, designated as Unit One and Unit Two, which are separated by a strip of privately owned land approximately one mile wide. Each of these units is in turn divided into two residential sections separated by low river-bottom land, this being undesirable for house sites while the bench land between the river and foothills on each side of the valley offers the most desirable locations.

Due to the scattered locations of the houses, the distribution system required an unusual amount of mains and service lines. There are 41,558 feet of mains composed of 2, 3, 4, 6 and 8-inch cast-iron pipe, and 35,610 feet of one-inch service lines, giving an average length of 154 feet of main per house and an average length of service line of 132 feet, some services reaching a length of 700 feet.

Contrary to the natural trend of rivers to follow a syncline, the Tygart river flows directly over an anticline for several miles of its length. This is illustrated more clearly by Figure 2, a geological cross section of the valley at the Tygart Valley Homesteads, which shows that the present Rich Mountain and Cheat Mountain are merely foothills, geologically speaking, of a mountain 6,000 feet high which once stood on the location now occupied by the Tygart Valley, and that, except for the relatively shallow top surface soil, the geological strata slope is from the river to the mountains instead of from the mountains to the river. In addition to this general slope of the rock strata away from the river, the strata in themselves are twisted and deformed, standing on edge in many places.

Generally in a valley, a large underground reservoir is formed by water entering porous rock which is exposed in the mountains and working its way to the val-



Map of the lands and building sites of the Tygart Valley Homesteads

ley where it is trapped between two impervious strata. By drilling into this water bearing stratum an adequate and practically undiminishable supply of water can often be obtained. But in the case of the Tygart river water shed, the water that enters into the porous

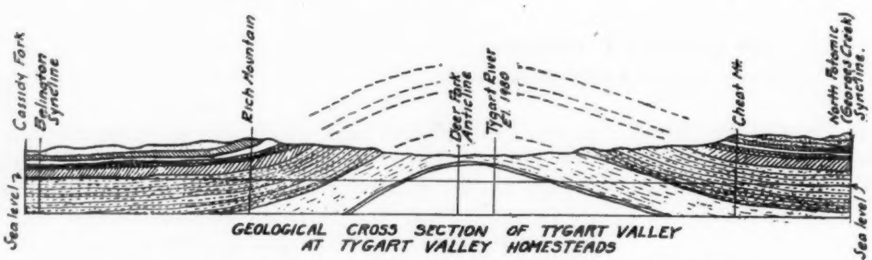


Fig. 2—Geological cross-section of Tygart Valley and adjacent hills.

strata flows, not into the valley, but under the mountain range to the other side, where it emerges in the form of springs.

This phenomenon makes the drilling of deep wells speculative and uncertain. Any water encountered by drilling deep wells would probably be from local pockets or from the river. Even if an adequate supply of water could be secured from deep wells, the difficulty of drilling due to the twisted strata would probably prohibit their use.

From a sanitary standpoint, shallow wells could not be considered, especially as it is necessary from an economical standpoint to use residential septic tanks for the disposal of sewage. A well and septic tank on each two-acre lot would create a health hazard that could not be tolerated.

As wells did not meet the water problem, another source had to be found.

Tygart river could supply all the water needed for the 270 houses, but it would require extensive chemical treatment. This would necessitate an expensive plant on each unit or one plant which would serve both units. If only one plant were used, it would be necessary to purchase a right-of-way through the private property between the two units owned by the homesteads. This did not seem feasible, so Tygart river was not chosen as the source of supply.

This left mountain streams as the most logical source of supply. On Unit One, which contains 173 houses, Shavers Run was available for this supply. This is a small stream with a water shed of seven square miles on which there are 17 houses. The water is soft and clear even during flood stage. Pumping of the water is necessary, as the fall of the stream is not rapid enough to secure a gravity feed with an economical length of pipe, about 5 miles of pipe being necessary to get the proper elevation for normal pressure.

The plans prepared for this unit call for a 3-foot timber dam, a concrete intake well sunk into the gravel bed of the stream, a centrifugal pump, a chlorinator, and a 100,000-gallon concrete-lined reservoir. Chlorine solution is to be added at the suction side of the pump. No filtering is considered necessary except that furnished by the large gravel of the stream bed, which will keep out the larger debris, while chlorination will be relied upon to destroy what bacteria there are in the water.

On Unit Two the features of the water system are unusual. On this unit there are no strong flowing streams. Buying a right-of-way through the intervening property and feeding a reservoir from the system on Unit One was considered, but rejected as too expensive. This leaves Sea Run, a small stream, as the only source of supply. The water shed of Sea Run lies largely within a national forest area, so its future protection is assured.

The flow of this stream is large during the rainy season, and large enough during normal stage for the consumption of the 97 houses dependent upon it; but in the dry seasons the stream bed dries up and for long stretches no water is visible. However, there are small pools of clear running water at places where rock outcrops in the stream bed. This led the writer to believe that the valley through which this stream flows is underlaid with gravel, through which the water travels when the flow is not strong enough to show on the surface. Whenever this underground stream comes to a rock barrier, it is forced to come to the surface and flow over it, thus creating these pools. At the time this investigation was being conducted, a large drainage ditch was being constructed on the project. At one point, this ditch intercepted Sea Run and it was noticed that a strong flow of water was seeping into it while no water showed upon the surface of the stream bed. This substantiated the underground stream theory. The total water shed for this stream is only three square miles, and that portion of it at a height sufficient for a gravity system is less than one-half square mile. Also, at the necessary elevation for a gravity system there is no place where a dam can be built which would furnish ample storage.

At a point 4,000 feet above the Tygart Valley Homesteads property line is an ideal site for a small dam. Here an earth dam 15 feet high and 300 feet long would create a storage of over nine million gallons of water, and there is an ample supply of material here ideal for the construction of this type of dam. As this location was not on the homestead property and would require the purchase of all land flooded, it was decided not to build the dam at the present time, but to use it as a future development in case an increase in the demand could not be met by the system as planned.

No stream flow records were available, but inquiries as to the condition of Sea Run during the 1930-31 drouth brought out the fact that the pools mentioned earlier in this article had never entirely disappeared but remained available for the watering of stock.

As there was no available way to secure a gravity system, it was evident that pumping of the water would be necessary as was the case in Unit One. A site was chosen for the pump house at a point where the hills converged to form a narrow neck 300 feet across. Test holes dug into the gravel deposit at this point to determine the depth of gravel and the probable quantity of water available showed the presence of the water in this gravel deposit in quantities to justify final decision as to the location of the proposed water supply for Unit Two. The gravel at the point chosen reached a depth of 23 feet, and was underlaid with impervious shale.

Plans were made to construct here a cutoff dam across the valley, stopping the flow of this underground water and storing it for the dry months. To do this, an im-

(Concluded on page 16)

Efficient Road Work With Relief Funds

By George E. Martin*

GRADING and drainage are the first operations in any highway improvement, but even a well graded and drained road is satisfactory for only the very lightest traffic. In general, roads of this sort are dusty when dry and do not have sufficient stability to resist deformation and rutting by traffic when wet.

Therefore, the logical step is to change the surface to one with sufficient stability even when wet to stand up under traffic. This requires the addition of some type of aggregate to the existing road surface, usually gravel or broken stone. Gravel containing a large percentage of sand is often used and in some parts of the country even straight sand, chert, shell, etc. Properly constructed roads of this sort get the traffic out of the mud but that is about all that can be said for them. Clouds of dust in dry weather obscure the vision and add to the probability of traffic accidents. Much of the loose aggregate on the surface is thrown off by traffic and lost. If the road carries any appreciable amount of traffic it will probably be cheaper to use a bituminous surface treatment than to attempt to maintain the road without it. Lost material and extra grading and dragging costs will more than pay for the treatment.

The majority of the roads, except in the South, will be gravel or a traffic bound type of broken stone. In the southern states top soil, sand-clay, lime rock, and similar surfaces are used. The improvement of any of these provides employment and benefits the community.

The gravel road before treatment may be solid and have practically no loose material on it, or it may have a greater or less amount of loose material on the surface. Both of these types of gravel road can be successfully treated, but they require entirely different methods.

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Tight surfaced gravel roads are those which are hard enough so that they can be swept. When swept, the surface should show a fair amount of aggregate above ¼-inch in size. The treatment is devised to get as much tar as possible down into the existing road surface, and produce a hardened crust rather than a mat on the surface of the road.

The steps for the treatment are as follows:

1. Shape the road with a blade grader [preferably in the spring] and start the treatment as soon as it has settled down. Successful work can be done in summer by scarifying the road, and permitting it to go back into shape under traffic.

2. Sweep the dust and loose material from the surface. The road must not be subjected to traffic between the sweeping and the first application of tar.

3. Apply cold refined tar TC-1 or TC-2 at the rate of 1/4 to 1/3 gallon per square yard. If the road must be left open to traffic, cover lightly with sand or road sweepings. If it can be closed do not use any cover and permit the tar to soak down into the road surface.

4. After at least twenty-four hours apply approximately 1/3 gallon of TC-4 or TM-2 per square yard. In the south TH-1 is also used.

5. Cover immediately with coarse sand, sandy gravel, pea gravel, or stone or slag chips. Small cover should be used with the light tars and the larger cover with the heavier tars. Only sufficient cover should be used to prevent picking up under traffic. This amount will vary from ten to twenty pounds per square yard. The cover may be distributed over the surface by brooming, but the cover should not be dragged in a manner which will break the bituminous seal.

Many gravel roads have an appreciable amount of loose gravel on their surface. To remove this and treat

the tight gravel underneath results in the loss of some of the best aggregate in the road. To conserve this material the following method of treatment commonly called the "mulch method" was devised. In practice new gravel is often added to the road to produce the mulch. Best results are obtained when there is about one inch of loose material on the surface with well consolidated gravel under the loose material. Greater depths can be handled, but the procedure must be modified, and the cost will be increased.

The object of the treatment is to add sufficient tar to the loose gravel to bind it together and to tie this tar-bound top to the solid material underneath.

The depth of the treatment is greater than that obtained in the treatment of tight gravel surfaces previously described, and a better surface is obtained.

The steps in the treatment are as follows:

1. Spread the loose material evenly over the road surface with a blade grader or drag.

2. Apply MT-1 or MT-2 over the loose material at the rate of approximately 1/3 gallon per square yard. MT-1 should be used in cool weather, and MT-2 in hot weather. Move the treated material on one side of the road about a foot past the center of the road with a blade grader, piling the material in a windrow near the center of the road.

3. Apply 1/3 gallon of the same grade of tar per square yard as a tack coat to the solid surface exposed by the operation of step 2.

4. With a blade grader move the windrow of treated material in the center of the road back over the wet tar.

5. Treat the other side of the road in the same manner, moving the loose tar-coated material about a foot past the center of the road with a blade grader, applying 1/3 gallon of tar to the solid material underneath and then move the loose treated gravel from the windrow back over the wet, liquid tar as in step 4.

6. Spread the loose tar-coated gravel evenly over the road surface and smooth out with a blade grader, planer or drag, so as to prevent ruts and holes from forming in the surface. The grading or dragging operations necessary to keep the road smooth should be continued until the tar sets up, which should be anywhere from one to five days, depending upon weather conditions.

Traffic should be allowed on the road to compact the surface. It is not necessary to roll this type of treatment, but if desired, the surface may be rolled with three-wheeled rollers, weighing not over 350 pounds per inch width of roll. The roller wheels should be kept wet to prevent picking up the surface.

7. Apply a seal coat of approximately 1/6 gallon of tar TM-1 or TM-2 per square yard and cover lightly with sand, pea gravel or stone or slag chips. Only sufficient cover should be used to prevent the tar from being picked up by traffic. It is good practice to delay the seal coat until after the road has been thoroughly consolidated by traffic. Where the surface is quite black, and it is evident that there is a slight excess of tar in the mixed portion, the seal coat may be omitted.

Repairs

Most gravel roads will require attention soon after they are treated. Gravel is not usually a uniform material and some breaks in the treatment may be expected. Shallow breaks should be given a coating of tar TC-1 or TC-2 and covered with clean coarse sand. A mixture of tar TC-1 or TC-2 and clean, coarse sand in the proportions of 17 gallons of tar to a cubic yard of sand can be mixed and stored along the road for patching. If small holes are patched with this mix as soon as they are formed there will be no big holes. The preparation and use of this mixture is a good small relief project.

Top Soil and Sand Clay Roads

Surfaces of this sort are used quite generally in the southern part of the United States. They have the same defects as gravel roads when untreated and are best preserved by a prime and seal treatment with bituminous material.

The steps for the treatment are as follows:

1. The road surface should be smoothed with a grader so as to produce a uniform, even support for the treatment. Dust and other loose material should be removed by sweeping.

2. A prime coat is needed to bind the aggregate in the road and furnish a solid support for the seal coat. Apply tar TC-1 or TC-2 at the rate of 1/3 gallon per square yard. No cover should be used and the tar permitted to soak into the road for at least 24 hours.

3. Apply hot refined tar TH-1 at the rate of 1/3 gallon per square yard.

4. Cover at once with approximately thirty pounds per square yard of pea gravel or stone or slag chips. The cover may be lightly dragged with a broom drag to distribute it more evenly over the surface and to aid in removing surface irregularities.

Rolling will assist in setting the covering aggregate into the seal coat and should be done if a roller is available.

Such roads should receive a maintenance seal coat of about one-quarter gallon of tar TM-2 per square yard with approximately twenty pounds of covering material, the year following the original treatment.

By the use of the methods outlined in the preceding article, a county, township, city or village can obtain smooth, durable and excellent low-cost surfaces. As shown in another article in this issue, such projects can often be financed under the $1400 limitation; but it will sometimes be necessary to include the surfacing as a part of a larger project, including grading and improvement of alinement. However, there can be no cheaper method of obtaining a first-class road than for the community to contribute, where necessary, the cost of supplying and applying the tar.

Tygart Valley Water Supply

(Concluded from page 14)

pervious clay core was constructed from the shale stratum to the ground level. As the dam is entirely underground and supported on both sides by the gravel fill, it was unnecessary to design for stability but only necessary to get enough thickness of core to stop the flow of water.

A dragline was available on the job and was used for construction of the cutoff dam and an intake well. The dragline bucket was four feet wide, giving a thickness of core sufficient for the purpose planned. This trench was backfilled with well puddled clay as the dragline excavated it. The bed of Sea Run is four feet below the ground level and at this point a concrete spillway was constructed to take care of all excess water. Trenches were dug from the intake well to the hills on each side of the valley and back filled with large clean gravel. These trenches intercept the water and lead it to the intake.

Before the cutoff dam was started, the intake well was excavated and poured. The dragline was used to do the major portion of the excavation. This intake well was originally planned to be 15 feet in diameter and 16 feet deep but while under construction the plans were changed, and the well was constructed 23 feet deep so that it rested on the shale stratum and made available all water stored by the dam. Holes were left in the walls at the bottom to allow the entrance of the water into the well.

It is estimated that the dam will store four to five months' supply of water, but this cannot be definitely determined without knowing the porosity of the gravel deposit.

The water is pumped from the intake well by a 100 g.p.m. centrifugal pump into a 200,000 gallon concrete-lined reservoir at an elevation 120 feet above the houses. The unusual size of the reservoir was considered advisable as additional supply to increase the storage created by the underground dam. Chlorine is added to the suction side of the pump in dosages that will give a residual of 0.2 p.p.m.

Chemical-Mechanical Treatment of Sewage

By Philip B. Streander* and Michael J. Blew†

The new order of chemical treatment, differentiated from the old order by the use of mechanical equipment in the handling and disposal of the sludge and in the feeding of the chemicals together with the technical supervision of operation and control, is a method that offers many interesting possibilities. It is a distinctly controllable process. not subject to biological phenomena. It is extremely flexible and is capable of carrying heavy overloads without upsetting the purification process or the results of treatment. Where a high degree of treatment is necessary, due to a low dilution factor, it can be employed as primary treatment effectively to remove the peak loads of oxygen-demanding materials prior to the application of the sewage to the biological units. Where conditions of dilution are such that primary treatment, or the removal of the settleable solids, does not provide a sufficient degree of treatment and yet complete treatment or purification is not necessary, chemical treatment can be used for practically all intermediate steps. Other conditions under which chemical treatment can be used profitably are in locations requiring a comparatively high degree of treatment during the summer season of the year or the period of low run-off and where, during the balance of the year, or period of high run-off, a lesser degree of treatment will suffice. With a plant properly designed for these conditions, it can be operated using the process of chemical precipitation and/or filtration during the summer months and as a plain sedimentation during the balance of the year. It is not amiss at this point to say that undoubtedly chemical treatment can eventually be employed in conjunction with the activated sludge process either as an adjunct thereof in the removal of the heavier solids, or as an integral part thereof in the continued biological and chemical treatment of the sewage.

USE of chemicals in treating sewage is not new. A patent for chemical treatment was taken out by De Boissieu in 1762, and hundreds were issued in England during the 19th century. The older methods of application, however, were crude and the knowledge of the chemical and physical principles involved extremely limited; consequently the results obtained were far from satisfactory. In addition the costs of chemicals (except perhaps lime) were high as compared to present-day costs.

The disadvantages of the old order have been overcome to a large extent by adoption of mechanism and control of coagulation and flocculation, utilizing advanced knowledge of the physics and chemistry of colloidal matter, and control by hydrogen-ion concentration. However, as is common with any new development, there is a certain vagueness and uncertainty regarding various processes or methods of chemical treatment recently developed or in the transitory state, and it is with the view to removing some of this uncertainty and vagueness that this discussion is presented.

Methods of Chemical Treatment

At the present writing there are a number of methods or processes for which various claims are made. Fundamentally all methods of chemical treatment are alike, differing only in the methods of flocculation, the kinds of chemicals used and the sequence of their application, the addition of various inert materials at different points of application, and (with one method) in the extension of the process to remove ammonia nitrogens. The purpose of all these processes is the removal of suspended and colloidal solids, this being accomplished by coagulation, settling or precipitation, which should in most cases be followed by mechanical filtration; and designing a chemical plant involves, not the choice of any particular process, but rather the design and arrangement of the component parts of the plant. Flocculation and chemical reactions, settling or precipitation, and sludge treatment and disposal, are integrally related in all chemical treatment plants; and discussion will be given of these individually, rather than of any particular process.

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Solids in Sewage

Solids contained in sewage can roughly be divided into three main groups, namely—(1) settleable, (2) colloidal and (3) dissolved. Chemical treatment deals chiefly with colloidal matter, as the efficiency of this method of treatment is due mainly to the coagulating effect of the coagulum or precipitate formed on the colloidal matter—calcium carbonate when using lime; aluminum hydroxide with alum, or ferric hydroxide with iron sulphate or iron chloride. There is also the absorptive effect by which the colloids are coagulated on the surfaces of the flocs and the enmeshing of suspended solids during the process of settling.

Colloidal Solids

Probably the most important and most general characteristic of colloids is that of large surface per unit of volume. The surfaces of the colloidal bodies possess electrical charges which tend to prevent their separation from the water. These charges are either positive or negative, depending to a large extent on the characteristics of the water supply. If all of the colloids carry a negative charge, the addition of acids (which carry a positive charge)should neutralize the negative charges and coagulate the colloids. If they carry a positive charge, the addition of an alkaline substance (which carry a negative charge) should neutralize the positive charge and coagulate the colloids.

As sewage is an extremely complex agglomeration of bio-chemical substances, it is likely that both phases of charge occur to a greater or less extent. For this reason the coagulation of sewage presents as many variables as there are variances in the sewage to be coagulated. Unrelated results cannot be compared, and to determine the comparative efficiency of various methods of chemical treatment, coincident and simultaneous tests must be conducted.

Efficient Coagulation

Efficient coagulation requires that the electrical charge be raised or reduced to the isolectric point of the colloid, which then coagulates and settles. Should more chemicals be added than necessary, the result is merely to change the electric charge and retard coagulation. Different sewages have variable isolectric points, and dosages used for the treatment of one sewage may be entirely inadequate or improper for the treatment of sewage at another location. Recent conceptions of the role of colloids lay great stress upon the determination of the hydrogen-ion concentration (pH) and its maintenance at or between certain fixed points. Such conceptions may be proper, but are entirely localized, and the results at one plant can not be assumed to be applicable to others. Good judgment must be used in drawing conclusions from pH determinations.

Chemicals Previously Used

Since almost the inception of chemical treatment, the coagulants mostly used consisted of lime, alum, and ferrous or ferric sulphate or chloride; although it is only during recent years that ferric chloride has been commercially available. In 1889 Hazen made a thorough experimental study of the various coagulants then in use for the coagulation of sewage. The precipitants tested were lime, alum, and iron (ferric) sulphate. He showed that "the most satisfactory results were those obtained with iron (ferric) sulphate; the second in order were copperas (ferrous sulphate) and lime; the third with lime alone; and the least satisfactory were with alum ———— Precipitation by copperas (ferrous sulphate) is also somewhat complicated, owing to the necessity of getting the right amount of lime mixed with the sewage before adding the copperas. When this is done a good result is obtained. The amount of iron left in the effluent is much greater than with ferric sulphate, owing to the greater solubility of ferrous hydroxide." Inert materials such as clay, coal dust, wood pulp or paper fibre and many others were added in conjunction with the coagulating chemicals. Also previously precipitated sludge was returned to and mixed with the raw sewage, and effluents from chemical precipitation plants were filtered.

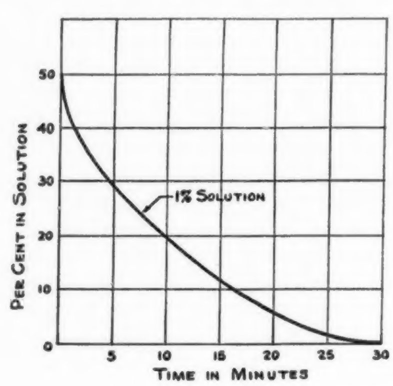


Fig. 2. Oxidation of ferrous sulphate by aeration

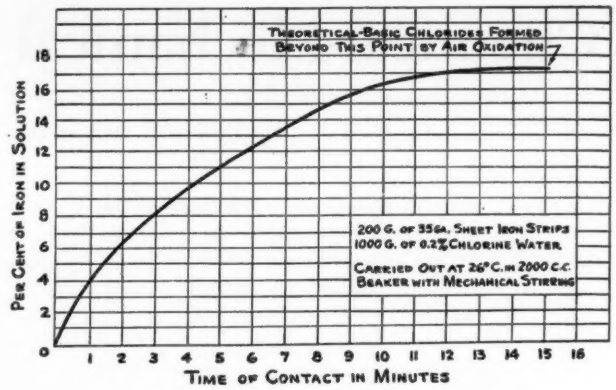


Fig. 1. Rate of reaction—chlorine water and iron

Chemicals Now Used

The chemicals now being used for the coagulation of sewage consist of ferric chloride (as either a liquor, crystal or in the anhydrous form), ferric sulphate and ferrous sulphate. As a general rule, ferric salts produce a larger and tougher floc than ferrous salts. Ferrous hydroxide is very finely divided and it is difficult to settle out or filter out except with a comparatively fine-grained filter medium.

One of the troubles with ferrous sulphate (copperas) in the old order of chemical treatment was in the production of ferrous hydroxide, which is soluble to the extent of about 8 parts per million, which soluble matter is discharged in the effluent to become subsequently precipitated when the liquor becomes aerated. Therefore it was formerly held that ferrous sulphate could not be used successfully with septic sewage or high organic wastes devoid of oxygen, as the conversion or oxidation of the ferrous hydroxide from copperas to the ferric hydroxide (the desired coagulum) is dependent on the presence of dissolved oxygen as well as the hydroxyl-ion. As ferrous sulphate is an inexpensive coagulant, various methods have been developed to allow its use. One of these is the addition of chlorine to oxidize the iron from the ferrous to the ferric form. Another is the addition of small air bubbles in conjunction with lime to aerate the ferrous hydroxide (formed by the ferrous sulphate and lime) to the insoluble ferric hydroxide.

The reactions involved in the use of the various coagulating salts are given in the following in a simplified form. Undoubtedly other reactions and counter reactions occur, depending on the characteristics of the water, but on account of the numerous complications involved they are not included in this discussion. All of the reactions are based on the supposition that the required pH adjustment is provided in the form of lime. With the use of ferric chloride and coagulation at a low pH, or where the alkalinity and pH of sewage will form the required ferric hydroxide, no lime is necessary.

(1) The addition of ferric chloride and lime to the sewage results in the direct production of the insoluble ferric hydroxide as follows:

$$3Fe\ Cl_3+3Ca\ (OH)_2=3Ca\ Cl_2+2Fe\ (OH)_3$$

(2) The addition of ferric sulphate and lime also results in the direct production of the insoluble ferric hydroxide as follows:

$$Fe_2\ (SO_4)_3+3Ca\ (OH)_2=3Ca\ SO_4+2Fe\ (OH)_3$$

(3) Adding chlorinated copperas (ferrous sulphate merged with a chlorine solution, oxidizing the ferrous to ferric sulphate) and lime to the sewage results in the same reaction as number 2.

(4) Adding ferrous sulphate and lime to the sewage results in the production of the soluble ferrous hydroxide, as follows:

$$4Fe\ SO_4+4Ca\ (OH)_2=Ca\ SO_4+Fe\ (OH)_2$$

(Continued on page 22)

The Editor's Page

Municipal Spending for Public Works

Whether wise or not, the decision has apparently been made by the powers at Washington that again expenditures of Federal relief funds must be confined very largely to direct employment of labor. When Congress first met, we seemed to be encouraged to believe that more thought would be given to the benefits obtained by the taxpayers from their relief money in the form of worthwhile and needed public works than was the case last year.

That money spent for materials goes to labor somewhere, even if not handed directly by the paymaster to the laborer, and other arguments are "old stuff" and we will not repeat them; but there is one point we would like to call attention to—a tendency to demoralization of public officials and taxpayers as well as of laborers.

With the Federal authorities offering money to communities by the tens and hundreds of thousands for constructing "public works," the natural tendency of officials and taxpayers is to look to that source for all their public improvements and refuse to spend anything from their own treasury for public works of any kind. This resignation to dependence is as unfortunate for communities as for individual recipients of aid; but there is danger that it may have another result—that needed improvements which require considerable expenditures for materials may be neglected.

Pumping plants need repairs or enlargements, but these may be neglected because little of the cost of them goes to "direct" labor. The same is true of elevated tanks, large water mains, etc.; of construction and repairs of high-class paving; of street lighting, refuse collection wagons and trucks, bridges; and of many features of sewer construction, treatment and purification plants; and river and harbor improvements and other work for which the use of machinery is almost necessary

Officials charged with the upkeep and extension of these utilities and of raising the funds for them must realize that Federal relief of unemployment is not a substitute for these regular duties but is supplementary to them. Cities which feel that it relieves them of all obligations to spend anything from their own treasuries for their public works will wake up before long to find their mistake a costly if not a calamitous one.

Six Years Without Gas Tax Diversion

If that portion of the money derived from gasoline taxes which was diverted in 1934 to other purposes had been applied to the elimination of dangerous grade-railroad crossings, nearly 5,000 of these could have been eliminated, according to Link-Belt Shovel News. Let us consider this again: In six years, 30,000 dangerous crossings would be removed. Every year 4500 persons are killed or injured at railroad crossings. The fruits of a rigid adherence to the honest policy of highway money for highway work would give a tremendous amount of work to those now unemployed, and would greatly reduce the toll of dead and injured.

Keep up to Date in Waterworks Information

Whatever virtue there once may have been in the plea that "water should be free as air," it exists no longer. Water as supplied to municipal consumers now is a manufactured product—much of it as much so as ginger ale or butter. Fifty years ago consumers ingested with the water they drank varying but very appreciable amounts of mineral, vegetable and animal matters in suspension, and there was little complaint (except when an occasional eel or fish worm came out of the faucet), for the condition was assumed to be unavoidable; the water company or department was merely a deliverer of water, and if the water it delivered was poor, why it was "just too bad"—which it usually was.

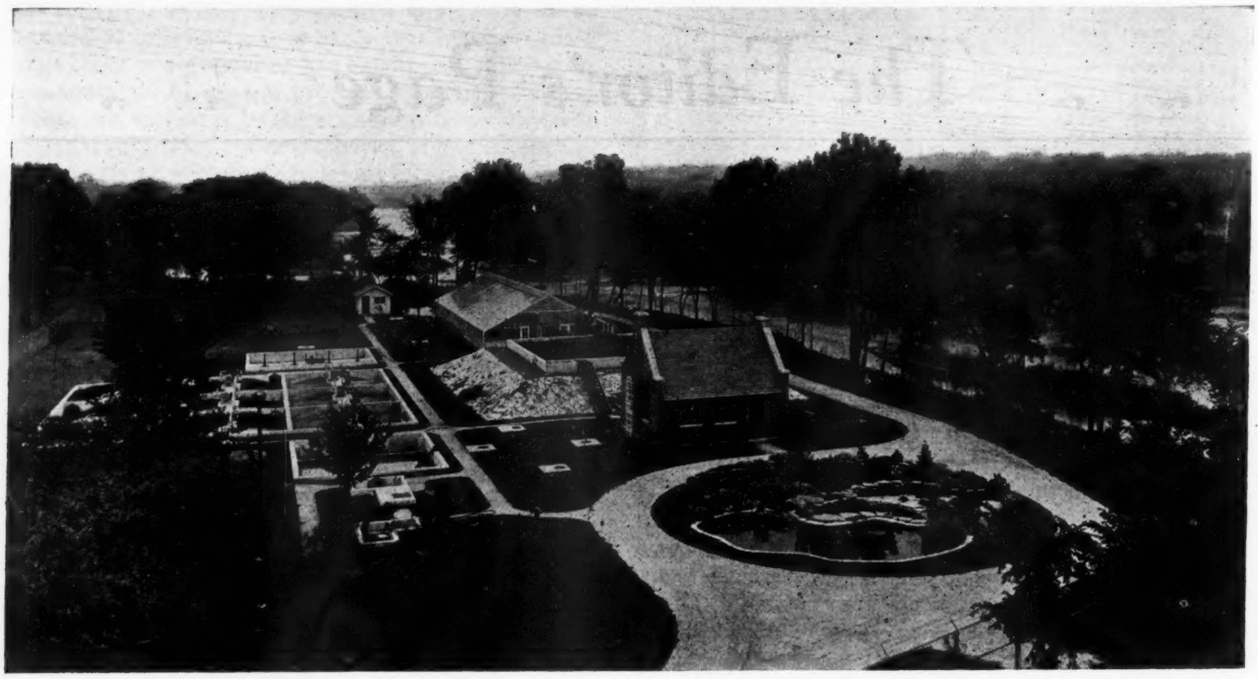
But now the water delivered has been freed not only of all appreciable suspended matters but even of the minerals in solution which are believed to be objectionable, especially iron and lime.

It follows that a waterworks superintendent must now know more than how to calk a pipe, make a tap and repair a hydrant, as well as run a pump if it is not a gravity plant. While he need not be a skilled chemist and bacteriologist, he should at least understand the language and enough of the principles to appreciate the findings of those who are and the significance thereof.

And both superintendents and engineers, especially the latter, should keep informed of the processes, procedures and equipment available and proved to be effective for removing the various objectionable matters in suspension and solution, including taste and odor. These are being added to every month, and as each of them is especially effective under certain conditions, a wise selection for a given case demands a pretty thorough knowledge of the science and art of water treatment—a knowledge more up to date than can be found in the text books, but which requires faithful reading of the periodic literature (a great aid to which is the *Water Wheel* section of *Public Works)*.

An illustration is offered by water softening. In this issue Mr. Hoover explains why he selected zeolite softening for New Philadelphia, and in the May issue Mr. MacDowell explained why he adopted pressure zeolite softening for Elmore and the lime-soda method for Grafton—three municipalities in the same state using three different methods of softening. Again, the June issue of *Public Works* discussed the use of chlorine in five different items, and of activated carbon in three.

Truly, if a waterworks superintendent or engineer should, through sickness or other reason, fail for only a year or two to inform himself on what is going on in his field, he would be seriously hampered if he tried to get back into practice.



Sewage treatment plant at Geneva, Ill.; view from railroad embankment. River at right and background

Performance of Geneva's Sewage Treatment Plant

By E. Roy Wells
Wells Engineering Company

THE City of Geneva, Illinois, located on the Fox river, approximately forty miles west of Chicago, in 1932-33 constructed a modern activated sludge sewage treatment plant. The project was undertaken partially as a relief measure, and partially in recognition of the need for adequate sewage treatment works throughout the Fox valley, known for its beauty and a favorite recreational spot for Chicago and environs.

The activated sludge process of treatment was chosen by the engineers, the Wells Engineering Company, for reasons which were considered vital under the circumstances. The sites available for a treatment plant were restricted in area and critical in location. The available land adjacent to the river was all within comparatively close proximity to residential sections, and the location of existing sewer outfalls further restricted the choice of sites. The site finally selected was secured from land owned by the State of Illinois Training School for Girls, being a peninsula along the east side of the Fox river near the southerly limits of the city containing three acres, which provided ample room for the plant.

Basis of Design

Population forecasts of the Chicago Regional Plan Commission indicated that the 1950 population, together with the contributing population of the State Training School for Girls, would require a plant adequate to serve 8,500 persons. The per capita flow was taken at 100 gallons per capita per day, based upon records of water pumpage of the city waterworks and of the Girls School, and subsequent experience has proven the dry-weather flow to be approximately that figure.

The city's sewage is almost entirely domestic, there being no trade wastes of any consequence to be cared for. It is somewhat stronger than the average, but is quite amenable to treatment by the activated sludge process, and no difficulties of operation have been encountered on that score. While the present contributing population is approximately 5,500 persons, the equivalent population, based upon the 5-day B.O.D. of the raw sewage, is more nearly 9,000.

The city's sewage is brought to the plant through cast iron siphons intercepting three separate existing sewer systems, and that from the Girls School is brought to the plant separately, the two flows being combined at the entrance of the screen chamber. No grit chamber was provided as the sewers are all of the separate sanitary type.

No unusual problems of design or construction of the plant were anticipated or encountered. The Niagaran limestone lies but a few feet below the surface of the ground and provides an excellent footing for structures of this type. It was not necessary to sacrifice either adequacy or appearance of the finished plant in the interests of rigid economy, although due regard was given to costs. The critical location of the site was largely responsible for the choice of a glass enclosed sludge bed, and the plant was planned to present a symmetrical appearance with no suggestion of being crowded, and future additions may be made in the space between the present units when needed.

Description of Plant Units

The screen chamber is provided with a manually cleaned coarse bar screen, set at an angle of 45 degrees. Clear opening between screen bars is 1⅝", being somewhat large in order to provide against excessive clogging during the night when the plant would be unattended.

Leaving the screen chamber, the flow up to 3 mgd

is metered by a depressed Venturi tube with its register located within the service station; a bypass channel taking direct to the river without primary sedimentation all in excess of this amount. (In Illinois it is generally allowable to bypass flows in excess of 500 g.p.c.d.)

The rectangular primary tank provides a detention period of 1½ hours at average design flow. It is a plain sedimentation tank with hopper slopes at 55 degrees. The inlet is in the form of a trough with stop gates at either end and submerged ports in the floor of the trough. The distribution of velocities through the tank has been satisfactory, and the reduction in suspended solids has averaged 51.2% for the year 1934. The outlet is provided with two sets of weirs by means of which the effluent may be divided and all in excess of 200 g.p.c.d diverted to the river after primary settling, providing automatic protection to the aeration tanks against excessive flows.

Nine aeration tanks equipped with mechanical surface aerator mechanisms are provided, stop gates permitting operation of any number of units in excess of four. Each tank has a capacity of 38,100 gallons, the nine tanks giving an aeration period at design flow of approximately 7½ hours when returning 25% of sludge. The plant has operated with five aerators in service since October 1933 with the exception of three months during the summer of 1934.

The final sedimentation tank is divided longitudinally and equipped with flight-type sludge collecting mechanisms. The detention period at design flow is two hours. The outlet weirs are H shaped troughs with a total weir length of 102 feet, the overflow rate at design flow thus being 8,333 gallons per foot of weir per day. At design flow and with 25% return sludge, the sedimentation rate is 1,110 gallons per square foot per day. Sludge is taken from the hoppers by four lift pipes operating by hydrostatic head and discharging into a trough leading to the suction pipe of a horizontal centrifugal return sludge pump, with a similar pump for standby. The sludge lift pipes were originally 6" in diameter, but were found to be too large to secure a satisfactory velocity, and liners reducing the diameter to 4" were later installed. The return sludge is pumped to a division box located on the side of the digester, and pipes are provided whereby waste activated sludge may be sent either to the digester direct or to the primary tank for settling with raw sewage. The latter has been the practice since placing the plant in operation.

A digestion capacity of 2.5 cubic feet per capita is provided in a tank 40 feet square and equipped with floating cover and heating coils. The digestion gas is collected and furnishes all the fuel needed for heating both the digester and the service station, and during portions of the year there is an excess which is burned in a waste gas burner mounted above the roof of the service station. The berm surrounding the digester is paved with limestone flagging laid random on a slope of 1½ to 1, which eliminates the labor of mowing a sodded slope and presents a very pleasing appearance. The top of the digester is reached by means of a steel stair leading to the division box. A supernatant drawoff chamber is provided with overflow and drawoff valves at three levels. Digested sludge is discharged by gravity to the sludge beds throughout an 8" cast iron pipe.

The sludge beds are covered by a glass enclosure of the conventional type, equipped with an overhead monorail track with two travelling dump buckets. Dried sludge is shoveled or forked into the buckets and conveyed to the rear end of the enclosure, where a stub track extends out over a driveway, allowing the sludge to be dumped directly into trucks. The sludge bed area is 3,840 square feet, or 0.45 square foot per capita at maximum plant capacity. The bed is divided into four equal sections, using structural slate plank instead of the usual wood or concrete. The slate is no more expen-

Above—Final sedimentation tanks. Below—Laboratory in service station

sive and has proven most satisfactory, there being no tendency for sludge to adhere to it as in the case of wood or concrete. The drying sludge cake pulls away from the slate cleanly.

The plant laboratory and service station is a brick structure with slate roof. The sludge pumps, switchboard, gas-fired boiler with flame trap and other appurtenances are in the basement, and the Venturi meter register, laboratory benches and desk are on the first floor. An investment of about five hundred dollars in apparatus and chemicals enables the operators to carry out all necessary control tests.

The entire plant is fenced with an industrial type woven wire fence provided with double gates at the entrance and at the rear of the site. A gravelled drive extends to the plant from State Highway No. 25 and along the river side of the site to the rear of the sludge bed, with turning circles in front of the service building and at the sludge bed. The site was seeded and a beautiful lawn has been developed over the entire area within the fence. Shrubbery and flowers, together with a pool and rock garden, contribute to the beautification of the plant. City water under a high pressure is available through a 4″ main, as well as city gas. Floodlights are provided which illuminate the entire site.

The sewage metering equipment was furnished by the Simplex Valve & Meter Co.; the mechanical aeration equipment by the Simplex Ejector & Aerator Corporation; the sludge removal equipment in the final tanks by the Link Belt Co.; the Downes floating cover by the Pacific Flush Tank Co.; the dried sludge conveyor equipment by the Richards Wilcox Mfg. Co., and the sewage pumps by the American Well Works.

Operating Results

While the beauty of the plant has been a source of much gratifying comment on the part of visitors, the operation results have been no less gratifying. The

CHEMICAL RESULTS, GENEVA PLANT

	Susp. Solids—PPM		*Total Volatile Solids—PPM*	
	Annual Average	*Per Cent Reduction*	*Annual Average*	*Per Cent Reduction*
Raw sewage	287	—	559	—
Settled sewage	140	51.2	417	25.4
Final effluent	9	96.9	274	51.0
	Oxygen Consumed—PPM		*5-Day B.O.D.—PPM*	
	Annual Average	*Per Cent Reduction*	*Annual Average*	*Per Cent Reduction*
Raw sewage	68	—	340	—
Settled sewage	37	45.6	168	50.3
Final effluent	12	82.2	10	97.0

plant was placed in operation on October 1, 1933, and was called upon immediately to assume the full load of the city's wastes. The digester was immediately given the full burden of the sludge and not a pound of either primary or waste activated sludge has been bypassed during the plant's life. Careful watching and control of the digester, with moderate liming from the start until the digester was broken in, served to prevent any trouble with this unit, only one case of incipient foaming lasting but two days having occurred.

There follows a short summary of the operating results achieved during the year 1934, being the first full calendar year of the plant's operation:

Average daily flow	509,000 gals.
Average aeration period	7.14 hours
Average return sludge	25%
Dry solids to digester	1073 lbs. per day
Volatile solids to digester	799 lbs. per day
Gas yield	7,022 cu. ft. per day
Gas per capita	1.4 cu. ft.
Gas per pound volatile	8.8 cu. ft.
Average digester temperature	76 deg. F.
Average digester pH	7.1
Total electric energy consumed	235 Kw. Hr.
Total sludge drawn to beds	180 cu. yds.
Total dry sludge removed	35 cu. yds.

The citizens of the City of Geneva are pretty proud of their plant because of its efficiency and pleasing appearance and the knowledge that they are contributing to the restoration of the Fox river to its proper place as one of the more beautiful rivers of the state.

Chemical-Mechanical Sewage Treatment

(Continued from page 18)

(5) Adding oxygen to the sewage in the form of minute air bubbles and with the additional oxygen secured by atmospheric absorption, converts this into the insoluble ferric hydroxide, as follows:

$$4Fe\,SO_4+4Ca\,(OH)_2+O_2+2H_2O=4Ca\,SO_4+4Fe\,(OH)_3$$

The volume of air required for the oxidation of the ferrous hydroxide to the ferric hydroxide depends largely on the efficiency of the aerating mechanism used. Experiments conducted by the authors indicated that a volume of air equal to between 1/12 and 1/8 cubic foot per gallon of sewage caused complete oxidation and provided a dissolved oxygen residual of about 5.0 ppm in a raw sewage having no dissolved oxygen.

(6) It is also possible to produce ferrous chloride in the treatment plant by passing chlorinated water through towers containing scrap iron, resulting in the production of a solution of ferrous chloride.

$$Fe+Cl_2=Fe\,Cl_2$$

Approximately equal amounts of chlorine and iron are required to produce anhydrous ferrous chloride. The actual rate of the reaction of chlorine water and iron is shown in Figure No. 1.

The control of the rate of ferrous chloride production consists merely of varying the rate of chlorine fed into the towers. Such a control is quite simple and could probably be automatically controlled either in accordance with the rate of sewage flow or by means of a clock mechanism arranged to control feeds at predetermined rates and time intervals.

(7) The addition of lime and ferrous chloride results in the production of the soluble ferrous hydroxide. Adding oxygen to the sewage converts this to the insoluble ferric-hydroxide.

$$4Fe\,Cl_2+4Ca\,(OH)_2+O_2=4Ca\,Cl_2+4Fe\,(OH)_3$$

The use of either ferrous sulphate or ferrous chloride as the coagulating chemical with lime and aeration requires longer periods of contact in the mixing and aeration tank. Experiments conducted by Blew, Fig. No. 2, indicate that about 30 minutes is required to fully oxidize the ferrous sulphate.

(The second installment will appear next month)

Relief Workers and Compensation

The results of physical examinations of 66,543 relief workers in West Virginia showed:

Capable of ordinary work	47,194	70.9%
Capable of light work only	13,530	20.3%
Temporarily unemployable	3,369	5.2%
Permanently unemployable	2,450	3.6%

The medical examination necessary in making this classification provided valuable data from a number of standpoints, one of which was that of future compensaiton benefits resulting from injuries and accidents. Of 2184 accidents resulting from construction hazards over a 6-month period, 1094 required medical attention.

The average total cost, including compensation paid for injuries, medical and hospital expense and salaries, amounted to 30.1 cents per $100 payroll. This does not include all injuries, since some were cared for through local relief authorities. Assuming that, if these were included, the cost would have been 50 cents per $100 payroll, the total is still much less than the rate obtainable through the West Virginia Compensation Fund. Through this fund the lowest rate per $100 payroll would have been $1.50, plus a loading cost for administration of 20%, or $1.80. After the first year, if experience justified, this might have been reduced to $1.17 per $100 payroll.

Zeolite Water Softening Plant Built With FERA Funds

By Charles P. Hoover,
Sanitary & Water Purification Engineer, Columbus, Ohio.

THE new zeolite water softening plant at New Philadelphia, Ohio, built with funds obtained from the Federal Emergency Administration of Public Works, was put in operation the latter part of April, 1935. The water supply, taken from wells, is areated, settled, and softened by synthetic zeolite. The hardness is being reduced from 385 parts per million to 70 parts per million. The plant has a present normal capacity of two million gallons per 24 hours. An extra softening unit, not equipped, has been installed. When it is equipped, the plant will have a capacity of three million gallons daily. The cost of building the plant, including two 1,000 gallons per minute high-service pumps, was a little less than $72,000.

New Philadelphia has a population of about 12,500 and is located about 100 miles northeast from the center of the State, or from Columbus, Ohio. The raw water supply shows the following analysis, results, except pH, being expressed in parts per million:

Alkalinity	215
Noncarbonate hardness	170
Total hardness	385
Chlorine as chlorides	24
Manganese	0.5
Iron	trace
pH	7.5

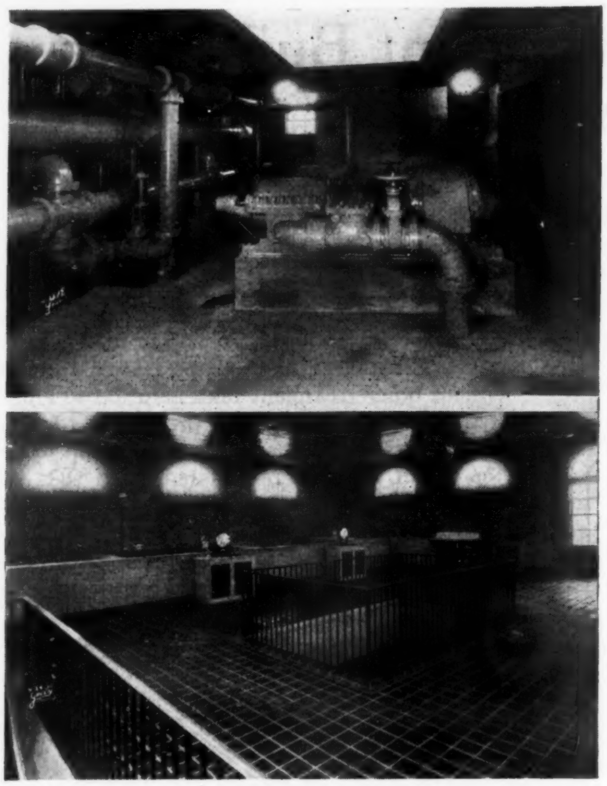
General layout plan, New Philadelphia water plant

Zeolite, rather than lime and soda-ash, was selected for softening for the following reasons: 1. The well supply is sparkling clear and can be passed through zeolite without other treatment than aeration to eliminate free carbon-dioxide. 2. The proportion of noncarbonate hardness to total hardness is high and would require the use of a considerable quantity of soda-ash to soften it; thus the cost of softening by zeolite is no greater than by lime soda-ash. 3. The cost of building the plant is less than a lime-soda-ash plant. 4. Operation is simpler. 5. There is no sludge problem with which to contend.

The New Plant and Operating Procedure

Aerator and Retention Basin. The raw water from the wells is pumped to an aerator pipe located on top and at the end of the raw water basin. Discharging from the numerous outlets from this aerator pipe, the water flows lengthwise across the roof of the raw water basin and drops into it at the other end. The discharge of the water through these openings on to the roof allows a portion of the free carbon-dioxide to be freed from the water. A float switch in the raw water basin controls the deep well pumps, restricting the maximum variation in water level to three feet.

Zeolite Softening Units. From the raw water basin about 82% of the water flows into the zeolite softening beds. This 82% passes downward through the bed and discharges into the clear water storage basin, producing a mixture with a hardness of about 70 parts per million. Each zeolite unit has an inside dimension of 11′ x 11′ and contains 743 cu. ft. (depth 6 ft.) of manufactured gel type zeolite, which is supported by four layers of graded gravel 12″ deep. A freeboard of 3 ft. is left above the surface of the zeolite bed and two transite collecting troughs are provided above the freeboard level. Transite troughs are made of an asbestos preparation and were used instead of steel troughs because, unlike steel, they are not corroded by the brine solution used to regenerate the softeners. The softening units are provided with a forebay similar to that used with gravity sand filters. Each softening unit is provided with a five-valve operating table, on which is mounted a recording and indicating rate-of-flow gauge showing the flow through the unit. A proportioning mechanism, actuated by Venturi tubes in the zeolite influent line, operates a hydraulic gate valve in the by-pass line. Any de-



Above, pipe gallery, showing pumps. Below, main floor of building showing open well and operating tables.

sired proportion of hard to soft water can be maintained.

Clear Well. A clear well is provided with a capacity of approximately 100,000 gallons and is provided with a float-operated depth gauge.

Wash Water. A 1000 gpm wash-water pump, taking its suction from the raw water basin, furnishes water for washing and regenerating the softeners.

Salt Storage Basin. The salt storage basin is of concrete construction with its floor at approximately the level of the pipe gallery floor. The inside dimensions are 14′ x 14′ x 7′ 4,″ and it holds about 40 tons of salt. The top slab is provided with four standard size manholes for convenient filling. The bottom of the storage basin is sloped to a rectangular trough which is covered with half sections of drainage tile. A layer of gravel is placed in the bottom with a depth of 12 inches above the trough. A brine measuring tank (concrete construction) which measures 8′ x 9′ x 10′ deep, is located in the pipe gallery. Valved connections are provided from the underdrain of the salt storage basin into the brine measuring basin so that saturated brine can be admitted. Valved lines also extend from the wash-water header in the pipe gallery to the top of the salt storage basin and the bottom of the brine measuring tank so as to furnish water for dissolving the salt and diluting the brine. The water enters the bottom of the brine measuring tank through a grid system so as to produce violent agitation of the brine with the dilution water. All valves are hydraulically operated from a three-valve table located on the operating floor directly above the measuring tank. A double float-operated depth gauge is mounted on this table, showing the depth of water in both storage basin and measuring tank. The storage basin is carried full of water at all times. The amount of brine necessary for the regeneration of one softener unit is drawn into the measuring tank at one time, and then is diluted to approximately 12° Baume.

Regeneration of Softener. A centrifugal pump is provided in the pipe gallery which takes its suction from the brine measuring tank and discharges through a brine header to the surface of the zeolite units. This pump is started by push button switches, mounted on the end of each zeolite operating table, and is stopped automatically by a float switch in the measuring tank when the proper quantity of brine has been delivered to the softening unit. The brine enters the freeboard above the zeolite through a distribution system which distributes the brine evenly over the bed. After the brine has been introduced, water is drawn into the basin in the space above the beds, and allowed to flow downward through the zeolite at a slow rate, after which the bed is washed free from salt.

Results of Operation. The plant has been in operation for only about one week, therefore no reliable results of operation are as yet available. Preliminary runs indicate that the zeolite used has a capacity of about 11,000 grains per cu. ft. and the salt consumption is about 1/3 pound per thousand grains of hardness removed.

Personnel

The preliminary investigations, the preparation of detailed plans and specifications, the supervision of construction, and starting up of the plant were under the direction of the author, with the assistance of John C. Prior, Columbus, Ohio. Carlton S. Finkbeiner prepared the detailed general plans and J. S. Myers designed the building and architectural features. Albert Rosch, civil engineer of New Philadelphia and part time city engineer of that city, had direct charge of construction work. Wendling Brothers Company, Dover, Ohio, were the general contractors. The International Filter Company furnished the operating tables, filter controllers, and filter bottoms. The Permutit Company furnished the zeolite, and Manistee pumps were used. The splendid cooperation, friendliness, and help of G. A. Reilly, P. W. A. Inspector, Geo. W. Platz, President of City Council, the members of Council, Mayor Carl D. Gross, Service Director Thos. H. Edwards, and City Auditor Ray L. Swinderman, made the project a pleasure for all concerned in its design and construction.

Rubbish Collection in Akron

Annual collections of rubbish are made by the street cleaning department of Akron as an added service on those streets which are assessed for cleaning. Generally only one collection a year is made, but occasionally more. In doing this work, the city is divided into 13 districts, each of such size that it can be covered in one day with the equipment of the Street Cleaning Division.

Three days in advance, each district is posted with signs on telephone poles, thus giving the residents time to gather up the rubbish and place it in boxes, barrels, bags and other containers, which are placed at the curb on the day of the collection.

The collection completed a few weeks ago amounted to 7,230 cubic yards. The cost was 42 cents a yard, which cost includes posting of signs, gas, oil, trucks, labor, etc. The average weight per cubic yard of material was 320 pounds.

All material which has a salvage value, such as paper cartons, rags, iron, sheet metal, aluminum, barrels, baskets, glass, bottles, etc., is salvaged by dump attendants. The remaining refuse is covered with dirt and ashes.

Laying Out a Refuse Collection Scheme

An unusually practical paper dealing with the details of street cleaning and refuse collection was read before the Institute of Public Cleansing, a British society, last November by R. J. Watson, director of cleansing and transport, Birkenhead. Papers on engineering matters dealing with practical details, which are written for English conditions and customs, generally are more or less inapplicable to those of this country; but that part of Mr. Watson's paper describing how to lay out a refuse collection scheme seems so applicable to United States conditions and gives suggestions so seldom found in print, that we think it very worth while to reproduce it.

IN LAYING out a refuse collection scheme, the first point is to fix the boundaries of the districts so as to keep the average haul down to a minimum; districts should be laid out with the disposal plant as the centre wherever possible. Unfortunately this is not always practicable, but, nevertheless, it is a matter which must always be considered.

The next step is to lay out the individual rounds. Previous experience will give some indication of the amount of work each particular type of vehicle will do, and I suggest that the round should always be planned on paper first. By doing this, one can get a comprehensive view of the whole of the round, and this is of inestimable value when actually putting the scheme into operation.

After the round has been planned, it is advisable that the cleansing officer, if possible, or, at any rate, one of his senior assistants, should go over the actual routes of the rounds. This is extremely important, as, for instance, it will often be found that by taking a refuse collection vehicle through back passages (which are not always clearly shown on ordnance sheets), several minutes per day will be saved by eliminating dead runs for the vehicles and men. These minutes per day are important—vitally important.

All "dead" journeys must be cut out if practicable. Ten minutes per day wasted by the motor vehicles, and, say, six collectors, means a total loss of approximately £25 per year. This is why I so strongly advocate that the lay-out of each round should be checked over actually on the district by some senior member of the department before the collectors commence work. When this has been done and the lay-out is found satisfactory, the vehicle and collectors should be sent on to the district, and the "free-lance" supervisor sent with them.

It is his job to see that the correct number of men load (particularly where the relay or container system is in operation), so that the vehicle, or container, is fully loaded by the time the empty vehicle or container arrives on the district. Often during the first week it may be found that the vehicle is not loaded in time, while in other instances it will be loaded too quickly.

This must be noted during the first week's trial, and the number of men altered accordingly for the second week's work. Where the haul varies considerably during the week, it will be found advantageous to vary the number of men. For example, it might prove economical to have four or five men loading in the early part of the week (when the haul might be comparatively long) but towards the end of the week (when the vehicle is working nearer the disposal point), to increase the number of loaders to perhaps six or seven. As already stated, this especially applies to a "relay" or container system.

The supervisor must also record the number of premises visited, the number of bins removed from each house, etc., and also note any trade refuse, or other matters of difficulty or interest.

Needless to say, the first week that the scheme is introduced cannot be considered final or satisfactory, as, of course, quite apart from any "teething" difficulties, the refuse will in all probability be collected on a different day from that to which the occupiers are accustomed. It is therefore essential that the supervisor should be with the collectors the whole of the following week, and unless any extraordinary difficulties have been met with, the round can, usually, then be considered fixed, *but for that period of the year only*. When rounds are fixed in the summer, the probability is that the collectors will not be able to complete them during the winter, whereas if they are fixed in the winter, there will be insufficient work for the gang in the summer. It is when dealing with factors such as these that an elastic organization proves its value.

If, when laying out several rounds in any one refuse-collection district, these are so arranged that at the end of the week they converge at the point in the district nearest the disposal point, any work that is left over in the heavy period of the year is all in a small compact area, and can easily and economically be picked up by additional vehicles. In the summer or the "light" period of the year, this additional assistance will probably not be required. The main point is to make sure that there is sufficient work for each round during the "lightest" period of the year, and then give assistance by supplying extra vehicles and men during the winter months.

I mentioned earlier on that the supervisor should make lists of the premises from which refuse is removed. These lists form the basis of the permanent organisation of every round. When they have once been checked and proved correct, they can be totalled and the number of premises cleansed each day by the collectors is made available. This number can, with very little clerical work, be charted, with the result that on any day of the week the work carried out on each round is clearly shown, and it is known whether or not assistance will be required in order that the round should be completed by the week-end. Also these charts enable quick and easy comparisons to be made with the work done on each round in comparative periods of the same or other years.

Needless to say, the charge hand of each refuse collection gang must be supplied with a copy of the round list, and have instructions that on no account must he depart from the route set out in it.

Metering and Water Consumption

A STUDY of water consumption, as affected by meterage, in 238 cities of the United States has just been completed by the editors of PUBLIC WORKS. The 238 cities studied were selected from some 600 furnishing information, the basis of selection being the completeness and apparent accuracy of the records kept.

Size of the Cities.—Of the cities studied, 15 had a population of more than 200,000; 18 a population between 100,000 and 200,000; 23 between 50,000 and 100,000; 24 between 30,000 and 50,000; 24 between 20,000 and 30,000; 52 between 10,000 and 20,000; and 82 a population of less than 10,000. New York, Chicago, Philadelphia and some other very large cities were omitted from the calculations.

Percentage of Metered Services.—The most surprising fact was the high proportion of metered services in most of the cities. Of the 238 cities, 200, or 84%, had more than 90% of their services metered. These figures seem even more striking if one turns back to the engineering journals or textbooks of twenty years ago and compares the figures of those days with the records of 1935. For instance, in a study made in 1917 by W. R. Hill, only 12 of 68 cities had over 85% of the services metered.

Detailed data on the percentages of services metered are:

% Metered	*No. of Cities*	*% Metered*	*No. of Cities*
100	161	50-59	6
98-99	15	40-49	0
90-97	24	30-39	1
80-89	8	20-29	2
70-79	4	10-19	1
60-69	1	0-10	15

The paucity of consumption data in the lower percentages results in somewhat unbalanced results if the effect of meterage on water consumption is to be illustrated. However, while unbalanced, the results are conclusive.

The Larger Cities

Of the 15 cities of more than 200,000 population, 13 had more than 90% of their services metered. Complete data follows:

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	9	98.3 gpd	153	71
98-99	4	108.8	124	92
50-59	1	123.	...	...
20-29	1	178.	...	...
	15	108.		

The statistics for cities in the population groups, 100,000-200,000 are very similar.

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	15	91.7	269	52
98-99	2	92.0	92	92
50-59	1	126.	...	...
	18	93.7		

As in the case of the larger cities, those in the next population group (50,000 to 100,000) show a very fine record in metering and in water consumption:

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	18	82.4	140	32
90-97	1	90.	...	...
80-89	1	132.	...	...
60-69	1	140.	...	...
0-9	2	102.5	127	78
	23	88.3		

The Smaller Cities

In the cities of less than 30,000 population, the proportion that are 100% metered falls quite materially. Whereas, in the cities of more than 50,000, 42 out of 56 reported 100% meterage, and 49 of them a meterage in excess of 90%, of the 182 smaller cities tabulated, only 119 reported 100% meterage, and 151 in excess of 90%. Judged from the records of the past, these figures are very high, however; and they show the great progress of the past few years in curbing water waste

In the group of cities with a population of 30,000 to 50,000, 24 were studied, with the following results:

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	14	79.2	128	50
98-99	2	54.5	59	54
90-97	3	83.7	117	59
80-89	1	67.	...	...
70-79	2	112.	130	94
50-59	1	132.	...	...
0-9	1	232.	...	...
	24	95.1		

The next lower population group, 20,000 to 30,000, shows very much the same results, and the two groups might, perhaps, have been included in the same tabulation:

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	17	75.2	107	36
98-99	2	72.	94	50
90-97	1	97.	...	...
80-89	2	110.	116	104
0-9	2	255.5	406	105
	24	93.7		

Grouped in the next bracket, that of 10,000 to 20,000 population, are 52 cities, with the following:

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	36	75.3	171	33
98-99	1	170.	...	...
90-97	5	80.0	113	38
80-89	2	83.0	112	54
70-79	1	48.	...	...
50-59	1	85.	...	...
30-39	1	102.	...	...
20-29	1	112.	...	...
0-9	4	167.	300	68
	52	85.6		

The greater number of the cities in the groups having less than 10,000 population, illustrates a little better the results of metering, and also shows more clearly that meterage of 90% or more of the services is extremely effective in reducing waste.

% Metered	*No. of Cities*	*Aver. Cons.*	*Max. Rpd.*	*Min. Rpd.*
100	52	79.6	287	20
98-99	4	45.8	65	27
90-97	14	69.3	176	31
80-89	2	108.5	117	100
70-79	1	75.	...	...
50-59	2	121.5	180	63
20-29	1	83.	...	...
0-9	6	181.7	358	120
	82	85.4		

The complete tabulation of the entire group of 238 cities shows that the average consumption was 89.1 gallons per person per day. A similar tabulation of the 200 cities having 90% or more of the services metered shows a consumption of 80 gallons per day.

(Concluded on page 30)


Perchloron
Greater SAFETY for SWIMMING POOLS
Wise pool owners everywhere are using Perchloron in their pools. They also use it in shallow foot baths to prevent the spread of athlete's foot . . . As a bleach and sterilizer in rinse water for towels and bathing suits...And in spray and powder form as an effective deodorizer and disinfectant.
Perchloron contains more than 70% available chlorine . . . Is easy to use . . . Always stable . . . Gives a uniform solution ...Requires no technical supervision...Is conveniently packed (1 dozen cans to the case) . . . No return containers to bother with . . . and the cost is little.
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Low Cost Road Improvement Through Stabilization

Stabilized road construction involves the use of gravel, crushed stone or slag, binder soils, and calcium chloride and offers the opportunity for the greatest possible use of local materials and the extensive employment of hand labor, especially when coupled with light grading, ditching, loading and raking. For this reason it has been used in many instances on relief project work, notably in Onondaga county, New York, where 6,000 workers have been employed and more than 350 miles of road have been improved since 1932.

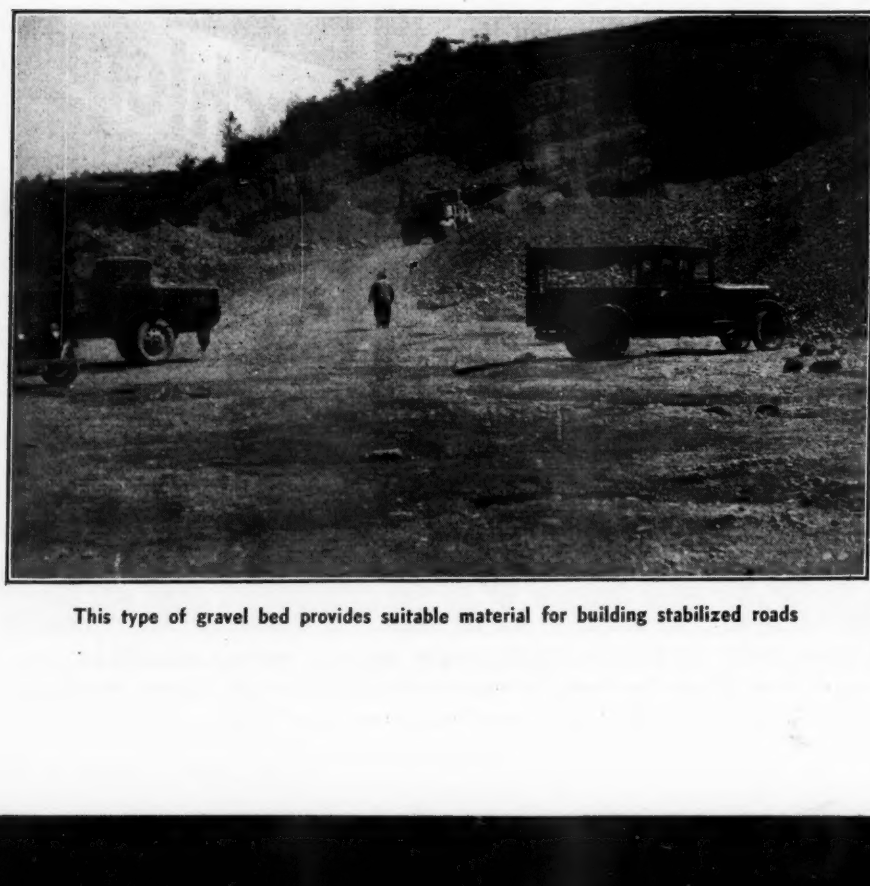
The term "stabilized surface" is used to designate a highly compacted wearing course which is produced by carefully combining aggregates and binder soils, with an admixture of calcium chloride. The surface is essentially a sand-clay-gravel road built to definite specifications with the addition of the calcium chloride to supply and retain the moisture which produces the cementing effect. When properly constructed and maintained, surfaces of this type become so hard that it is difficult to dig into them even with a pick; they are dustless in summer, and are highly resistant to spring thaws and rutting during wet weather.

In addition to its use on secondary roads, stabilized construction is now being used as a wearing course on city streets, as subgrade construction and for the treatment of shoulders along concrete pavements. One of the advantages of this type of surface is that it is well adapted to a stage construction program, providing an all-weather roadway superior to loose gravel until traffic warrants a higher type of surfacing, when it serves as an ideal base course for bituminous treatment.

Construction of the stabilized surface is comparatively simple. Before actual construction is started, a preliminary investigation of the surface to be stabilized and of the materials available is made. This is the only technical phase of the work. If the existing road surface material is to be used the gradation and nature of this material is determined by screen and moisture tests. Available materials are similarly tested and from these observations the quantities of new material to be added (usually clay) to produce the desired result is computed. It is noteworthy that there is a great variation in clays and that care in selecting the proper materials is important in obtaining the best results. Many county and state highway departments are now equipped to make these tests and calcium chloride producing companies now maintain soils laboratories and engineering personnel to render this service.

The three main factors which contribute to the stability of the mixture are: (1) density, which is obtained through the proper gradation of sizes from 1 inch stone down through the successively smaller sizes of coarse sand, fine sand, silt and clay; (2) internal friction, which is the resistance of the particles to sliding over each other and is furnished by the sharp sand and crushed stone or gravel, and (3) cohesion, which is the resistance of the soil and stone particles to being pulled apart and is furnished by the clay used in the mixture and by the moisture which is introduced at the time of construction and preserved by calcium chloride. Maximum operation of these factors is obtained by combining the various soils as indicated by the tests.

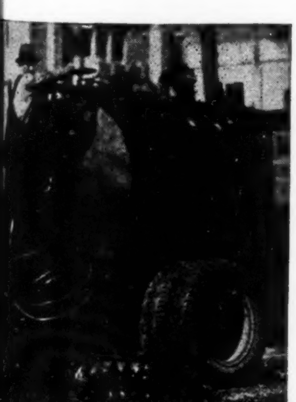
After the quantities have been computed, the clay is hauled to the road, placed in windrows and allowed to dry. Digging and loading the clay can be done by hand labor if desired. When the clay is thoroughly dry, it is pulverized by traffic, rollers or other equipment. The surface of the road is then scarified and all oversize stones are removed. This can be done either by hand labor or with a mechanical rake. The oversize stones are objectionable since they interfere with maintenance after the road is compacted. The pulverized clay and the calcium chloride to be included in the mixture are then spread evenly over the road and are mixed with the scarified material by blading back and forth across the roadway, until a thorough mix is obtained.



This type of gravel bed provides suitable material for building stabilized roads

The mixed material is then windrowed to the side of the road and the base is sprinkled using water tanks unless rain renders this unnecessary. The windrowed mixture is then spread over the road by the blade in thin layers of not over 2 inches depth, each layer being thoroughly sprinkled, until the entire mass is spread and moistened. The surface is then shaped with graders and rolled to compaction after which a light application of calcium chloride is made to the surface.

The amount of calcium chloride used is:



Rolling after materials have been spread and moistened. Knox County, Missouri

In the mixture—1.5 lbs. per sq. yd. for a 3-inch depth
On the surface—.6 lbs per sq. yd.
Total—2.1 lbs. per sq. yd.

This is about 11 tons per mile for a three-inch depth on an 18-foot surface.

In case a new course of gravel is to be placed on the road, the construction method is the same except that the old surface is not scarified and the new gravel is mixed with the proper binder soil. In some cases, plant mixing of the material is now being used but the road mix method offers greater opportunities for employing hand labor if construction is to be undertaken as a relief project.

The cost of stabilizing a gravel road naturally will vary somewhat on every section of road constructed, depending on the condition of the existing road, the availability of local materials including the length of haul, the width of surface and the thickness of mat. The use of hand labor in preference to labor saving machinery may also be reflected in the cost but is offset by the advantage of providing employment. On several Michigan roads where no new gravel has been added, the cost of stabilization has been as low as $300 a mile. In Indiana, the average cost on the stabilization of 130 miles of road in 1934, was approximately $500 per mile. These figures represent the cost of the binder soils and calcium chloride delivered on the road and the scarifying, mixing, sprinkling and compacting operations. Much of this is therefore a labor charge. Where a road is to be regraded, new culverts placed and new gravel added, the cost will be higher but additional opportunities for employment are offered.

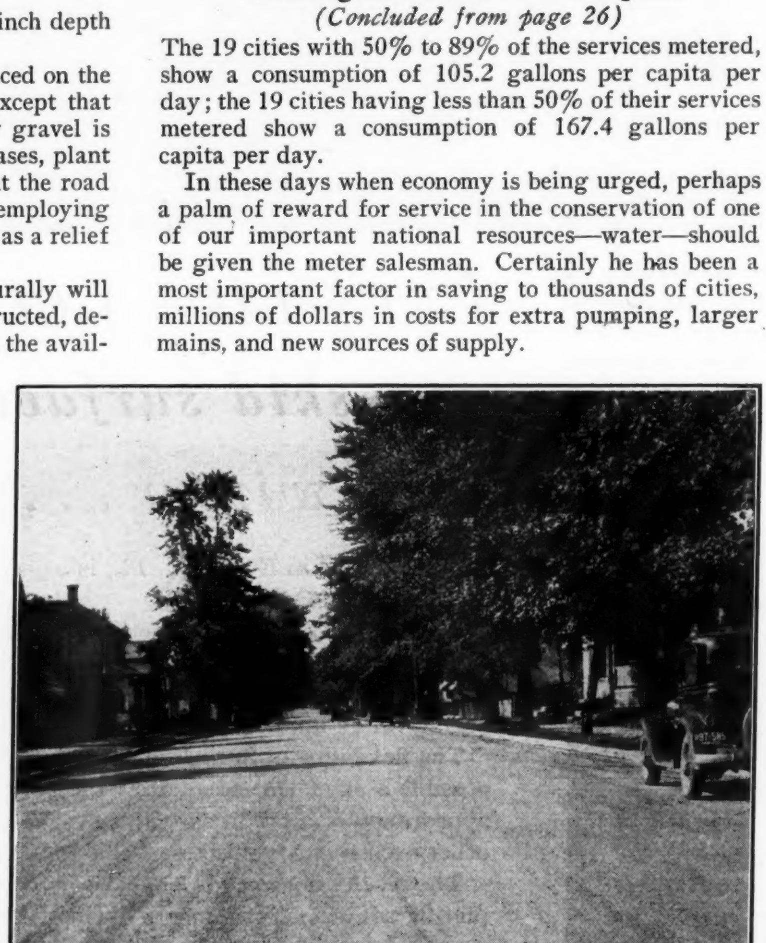
Mainteance methods on the stabilized road do not differ greatly from those used on an ordinary gravel road, except that there is a drastic reduction in the frequency of blading. Experience has shown that blading should be done only occasionally after a heavy rain. Occasional light applications of calcium chloride are made to the surface during the dry season to preserve the moisture bond and keep the road dustless, though again experience has shown that roads of this type are more receptive to calcium chloride and require fewer treatments than do ordinary gravel roads. As long as the moisture bond is retained, the stabilized road remains a closed, firmly bonded surface, practically impervious to surface water and highly resistant to traffic wear. Saving in maintenance is effected both by the reduction in the frequency of blading and in the saving of the gravel which is retained in a bonded compacted state, thus practically eliminating the loss of material by winds, rain and traffic.

Metering and Water Consumption

(Concluded from page 26)

The 19 cities with 50% to 89% of the services metered, show a consumption of 105.2 gallons per capita per day; the 19 cities having less than 50% of their services metered show a consumption of 167.4 gallons per capita per day.

In these days when economy is being urged, perhaps a palm of reward for service in the conservation of one of our important national resources—water—should be given the meter salesman. Certainly he has been a most important factor in saving to thousands of cities, millions of dollars in costs for extra pumping, larger mains, and new sources of supply.



This is a stabilized street in Piqua, Ohio

Work Relief By Road and Street Construction

By Bernard E. Gray

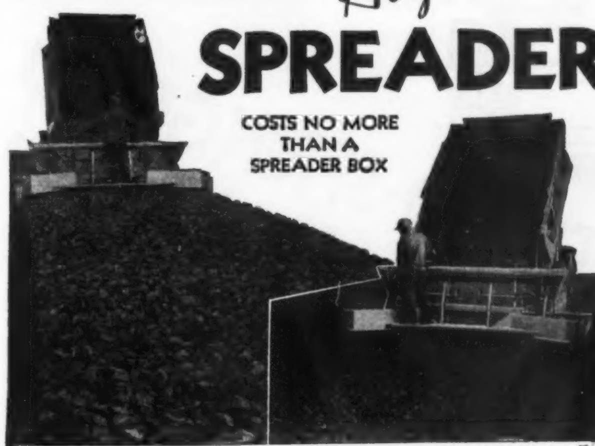
THE present discussion on the executive ruling which limits the character of work-projects so that each $1,400 will provide a year's employment for one man, appears to be between idealists on the one hand and realists on the other. Because construction technique has been developed in a certain manner so as to achieve a maximum amount of tangible results with a minimum use of labor, there has been an obscuring of the view that this is not always the only objective; and that now especially the more important one may be the maximum use of local labor with as high a tangible return as is consistent therewith. After all, if labor remains on unemployment relief, then there is *no* return in the way of tangible public works.

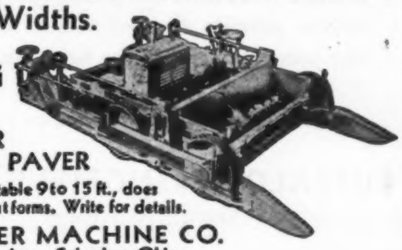
It is a matter of philosophy. If the Federal appropriation for the construction of public works has been made with the sole idea of obtaining the greatest possible amount of them, utilizing every improved machine, every mechanical means of preparing materials, and every labor-saving device for finishing operations, then the $1,400 restriction is all wrong. On the other hand, if the definite purpose is to give 3,500,000 men employment for one year, on public works that can be built with an expenditure of $1,400 per man year, the proper course for engineers and public officials to pursue is to select the best projects which can be built under these conditions, and to get them under construction without further delay.

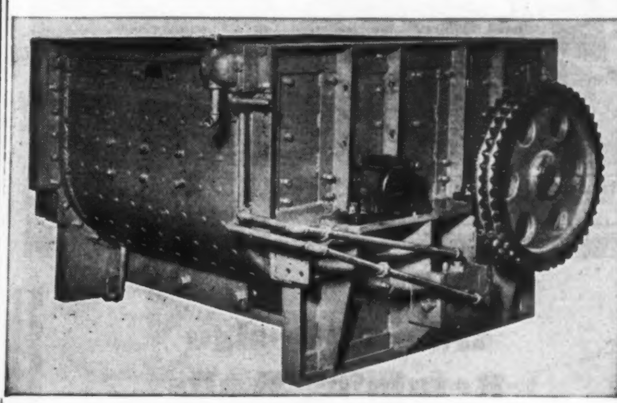
In presenting this suggestion the writer does not assume the position of defending such government expenditures as a proper recovery measure, or of advocating hand-labor as a general proposition when a machine will do it better. He simply accepts the situation as it exists, where a program has been laid out by duly constituted authority, and wherein if action does not soon take the place of talking, the summer will be gone, and everyone will be a loser.

Road and street construction and reconstruction constitute the largest single type of projects which may be adapted to the present requirements, both because of widespread distribution in close proportion to unemployed population, and because of the high degree of usefulness of such work when completed. It has been contended that only grading and drainage would be possible under the $1,400 restriction and therefore little could be done in the way of permanent improvement adjacent to large cities. This is not the case, unless it is further contended that money should be spent only on arterial highways, and one would hardly find justification for asserting that where the population is in the millions, the needed improvements on roads and streets are confined to but a few miles.

A great deal of desirable and worthwhile betterment work is needed not only on secondary roads in rural communities, but also on the streets of suburban cities.







There are literally thousands of miles of streets that were built in the development days, that now require widening, regrading and strengthening. At the same time water mains and sewers should be often relaid or reconstructed. This sort of work requires the maximum use of labor, and in the situations where new material is required in larger amounts, the cost can and should be met from local funds.

In a city about twenty miles from New York a typical project of this character was recently observed. The old street was a thin macadam, with a cobble gutter and stone curbing. It has needed reconstruction for at least five years. The improvement consists of removing the old stone curbs, cutting back the grass plot a foot or two on either side, and replacing the stone curb, using new material where necessary. The cobble or stone gutter is being widened with knapped stone and compacted by hand. Telephone and electric light poles are being reset at the same time, together with necessary wiring adjustments. Storm sewers are being relaid, and manholes reconstructed where necessary, using old material so far as possible. In several instances street intersections will be improved, and rock ledges removed which had been left too close to the road surface and which previously caused frost heaving in the pavement. Practically all these operations call for hand labor only, in fact it is probably better to do the work in this fashion than by machine because of the lesser inconvenience to the village residents. Finally a new surface will be placed using the old reconstructed and patched road as a foundation. The total labor charge will be a large percentage of the total cost, giving maximum local employment, while the community will have a worthwhile improvement adequate for the needs of many years.

A recent study indicates that on construction and maintenance of all types of highways in a certain state, the payment to labor on the job was about 35 per cent. This included some preparation of roadside material. Under the $1,400 restriction, in Region 1 there will be required about $700 direct payment to labor or 50 per cent. Even assuming the restriction to $1,100, with the lower wage rates in other regions, the countrywide average requirement will still not much exceed this proportion. It is necessary, therefore, to so select projects as to embrace certain items of work which will require more labor operations on the job.

The writer prefers contracting work rather than force account operations wherever possible, but under present conditions where time is important, a certain amount of force account work would appear desirable. On many projects the reconstruction, including grading, ditching, placing of stone and gravel bases, may be gotten immediately under way, with a contract placed as soon as possible to cover surfacing. The total cost of the project should be so made up that the labor cost meets the requirements. As an example, take the case of an old 16-foot macadam on poor alignment, which by judicious modification of curves, and widening on first one side and then the other can be made entirely satisfactory. The grading operations can be accomplished largely by hand; culverts can be extended and faced with stone masonry; widened foundations can be made with knapped stone or gravel; and the roadway extended to a twenty or twenty-two-foot width. A contract could then be let for a road-mix or plant-mix type surface using aggregates prepared by the contractor near the job; or the work done by force account. In this way the amount of material on which local labor was not used would be small indeed.

As previously stated this may not be the most desirable method or the most efficient, but it does meet the practical needs of the present situation, it does put men to work now, and the work done is durable, desirable and self liquidating. It is believed that state, county and city authorities might well be directing their attention to these possibilities.

Explosives Data

EXPLOSIVES for commercial uses fall within three classifications: (1) blasting powder, (2) pellet powder, and (3) high explosives, which include all of the dynamites, free-running powders, gelatins, and permissible explosives. This article will discuss but three types—blasting powder, dynamite, and free-running powder.

Blasting powder is the oldest explosive for commercial use. It is black, prepared in grains closely resembling fine lumps of high-grade coal. This is a deflagrating explosive; that is, it is fired by ignition and the gases are generated progressively as the burning spreads through the charge. It is the slowest acting of all of the explosives. It has a heaving, not a shattering, action, and hence tends to break down the blasted material in large fragments. A spark or flame is used for firing. A charge may be ignited by means of fuse, electric squibs or miner's squibs, or, in large blasts, by cordeau or by priming with high explosives.

Dynamite is a detonating explosive; that is, it is fired by shock from an intermediate agent known as a detonator, which may be a blasting cap, fired with a fuse; or an electric blasting cap which requires the use of an electric current. The transformation of a detonating explosive from a solid to gases is much more rapid than in the case of a deflagrating explosive, and the volume of the gases generated is much greater.

Dynamite is a mixture of nitroglycerin with wood meal and nitrate of soda or nitrate of ammonia, or both. Nitroglycerin is composed of several different elements; namely, carbon, hydrogen, nitrogen, and oxygen, the molecules of which are grouped in such a way as to form a heavy, oily, yellow liquid. These same molecules are, however, capable of arrangement in other groups to form several different substances instead of the one, and the bonds which hold them together in the particular arrangement which makes nitroglycerin are very weak. Consequently, when the detonator embedded in the dynamite is set off, imparting a sharp shock and a very high temperature to the nitroglycerin, the bonds between the molecules which compose this explosive are broken down.

All of this takes place in an instant and the highly heated and rapidly expanding gases exert a violent shock and sudden tremendous pressure on the rock or other material in which the dynamite was confined.

The so-called *free-running powders,* a rather recent and the latest development in explosives, are dynamites in granular form as distinguished from the types which are cartridged. Under certain conditions, bore holes can be loaded with greater facility when these "granular" dynamites are used. Also, they are better adapted to several purposes than are the dynamites supplied in cartridges, or sticks. They have been found especially useful for some kinds of highway construction blasting and for shooting down gully banks in soil erosion control work.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

MEASUREMENT of flow by weirs, using the Hamilton Smith formula, fails to give the true discharge, as determined by weighing, by between 1½ and 2%. Weighing tank calibration of the Venturi meter gave a coefficient of 0.976 in 1922 and 0.954 in 1934; with a departure from a smooth curve connecting these at no time exceeding 0.25%. The pitot tube "in the hands of trained and experienced men is a useful and accurate instrument." For very low velocities—0.15 to 3.0 ft. per sec.—the Bentzel tube was developed at the U. S. Waterways Experiment Station. This is essentially a vertical U-tube with the lower ends turned horizontal and in opposite directions; the downstream leg of the tube containing a tapered glass tube, small end up, in which is a float which stays at the small end when there is no flow, but is carried down a distance varying with the velocity of flow.[L5-1]

An elevated storage tank was built by Dallas, Tex., to give adequate pressure to an outlying section supplied through small distributing mains. This was adopted as an alternative to relaying the distributing mains with larger pipe, the cost of which was considered out of the question. In the summer of 1934 during morning and evening peaks, it was impossible for many consumers in this section to draw any water from their taps. In February, 1935, with the 1,000,000 gallon tank in use, an adequate supply was available at all hours; the electrically driven pumps operated against a more nearly uniform head, giving an increased load factor and reduced power cost; and consumption and revenue increased materially.

This tank was the first "torroidal bottom" elevated tank erected in the southwest. The bottom consists of a central circular continuous flat plate resting on deck beams and radial girders which are supported by an inner ring of columns. Outside of this the bottom is bowl-shaped, dished to a comparatively long radius, supported on its inner edge by the inner columns and on its outer edge by the outer ring of columns. Diameter 71 ft.; from ground to bottom of bowl, 71 ft., with maximum water line 35 ft. higher. Cost, $57,800, financed through the PWA.[G6-4]


Dallas elevated storage tank, with "torroidal" bottom

Coloring fire hydrants to indicate capacity is recommended by a committee of the American Water Works Ass'n, all barrels to be chrome yellow and the tops and nozzle caps to be painted as follows: Class A, flow capacity 1,000 gpm or greater, green; class B, 500 to 1,000 gpm, orange; class C, less than 500 gpm, red. Capacities to be rated by pitometer tests of individual hydrants at a period of ordinary demand; rating to be based on 20 lbs. per sq. in. residual pressure when initial pressures are over 40 lbs., and residual pressure at least half the initial when less than 40 lbs. Private hydrants in public streets to be entirely red. Location markers for flush hydrants to carry the same distinctive colors.

This has not yet been approved by the society. F. C. Jordan, discussing it, recommended not considering class C a fire hydrant at all, but turn attention to bringing up capacities of all hydrants. He believed firemen were not going to consider hydrant color when arriving at a fire, but would connect to the nearest hydrant regardless of color.[A6-15]

Cost of filtering highly colored river water at Peterborough, Ont., rapid sand, 3 hrs. sedimentation, average consumption 3.3 mgd (maximum hourly rate 10.8 mgd), average of 13 yrs., was $9.21 per mg (all U. S. gallons) delivered from the plant, comprising aluminum sulphate, $1.83; operators' wages, $3.32; power and light, $2.02; fuel for heating, $0.60; chlorine, $0.33; laboratory supplies, $0.13; repairs, $0.36; general, $0.62. Additional fixed charges averaged $21.08 per mg. Average costs were: alum, $1.40 per hundred pounds; liquid chlorine, $8.75 per 100 lbs.; coal, $15 per ton; power, 0.68 ct. per kwh; wages, $110 per month.[F6-5]

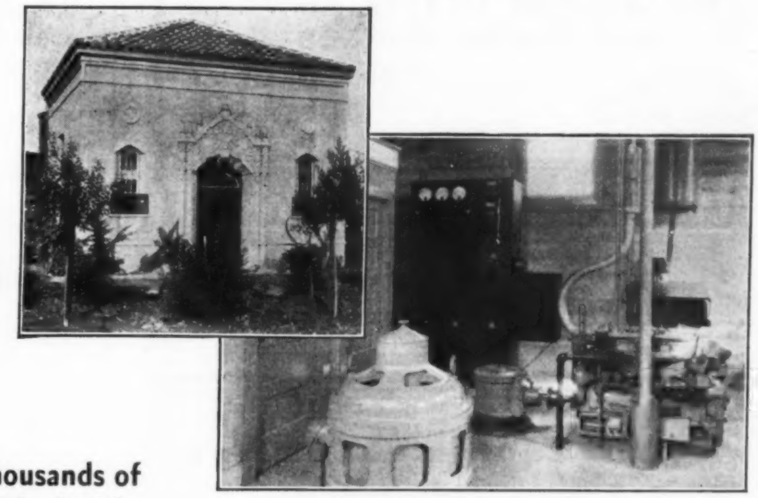
Blaisdell sand washing machine has been used by the Hartford, Conn., water bureau for washing 5.5 acres of slow sand filters since 1932. Previous to that, a Nichols type ejector and washer had been used. The cost by the latter had been $148 to $241 per bed per year; by the Blaisdell machine the cost has been $49 to $130, including repairs to machine. Not so many washings are necessary, an average of 1 to 1½ per bed per year as against 1.4 to 2.4 formerly.[F6-5]

Again Automatic Starting Saves Its Cost

If current fails, the gas engine functions within 25 seconds, automatically.

Sterling High Duty — Sterling — **Internal Combustion Engines**

THE ENGINE OF REFINEMENT



The Sewage Disposal Plant at San Rafael, Calif., is equipped with a Sterling Chevron C-4 cylinder 50 h.p. gas engine driving a DeLaval vertical sewage pump rated 5600 GPM, 23′ head at 860 RPM, as fuel 1100 BTU.

Automatic equipment is patented. Thousands of starts have been successfully accomplished without a single failure, and with no attendant present.

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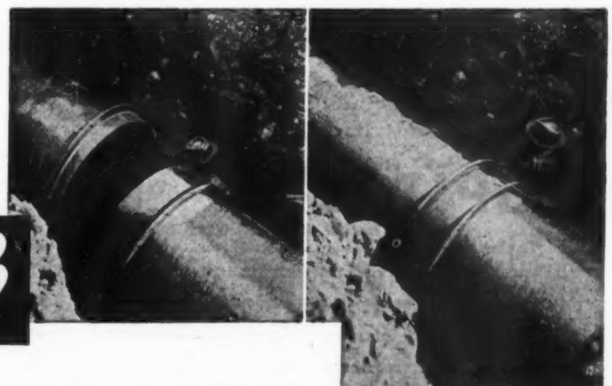
No matter how large or how small the pipe . . . Joint-Making is as

Simple as 1·2·3



THREE pictures tell the story of Dresser simplicity. (1) Component parts of the Dresser joint—followers, gaskets and middle ring—are slipped over plain ends of pipe. (2) Pipe ends are shoved into middle ring, and bolts inserted. (3) Bolts are tightened with ratchet wrenches, to compress gaskets between followers and middle ring.

Almost as easy as mounting a spare tire on a wheel! No lost motion. No special tools nor equipment. No skilled labor. The Dresser parts are ready to assemble—they fit correctly . . . go together in a jiffy. On 60" pipe or 3/8" pipe, there is no joint so easy to make . . . nor so permanently tight . . . as a Dresser Coupling. Engineers and contractors everywhere are enthusiastic over Dresser advantages. *Write for further information.*

S. R. DRESSER MANUFACTURING CO., BRADFORD, PA.

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with DRESSER COUPLINGS

Spectrographic determination of chemical constituents of 24 cities, from Boston to San Francisco, revealed presence of 30 elements; all supplies containing chemically determinable amounts of calcium, sodium, magnesium, silicon, aluminum, iron, copper and boron, and less amounts of strontium, borium, potassium, copper, silver and zinc; and most waters contained titanium, tin, lead, chromium, manganese, fluorine and nickel. This method is an extremely delicate one and the most nearly infallible for qualitative and semi-quantitative. It will detect one three-millionth of a milligram of soda, and one two-millionth of a milligram of manganese. It is "based on the distinctively characteristic individuality of the light radiation emitted by the atoms excited from each element present in the sample when it is subjected to a flame sufficiently hot to dissociate any radicle with which the metal may be combined and to vaporize the metal and ignite the metalic vapor." A6-16

Snow surveys are essential to approximate determination of the future yield of sheds in high altitudes. So general is the practice that a Western Interstate Snow Conference is held, which last year was attended by 43 representatives of states, cities, power companies and other organizations of Utah, Nevada, Oregon, Washington and California.

Systematized snow surveys require a group of fixed courses, surveyed, marked and mapped, on which measurements are taken each year to permit proper comparisons. If possible, enough parties are used to cover all basins at the same time, each party consisting of two or three men operating for two days or more. Los Angeles records show an error of estimate of runoff, using its snow survey figures, of not more than 10% for the past four years. A6-18

Pipe coating flaws are detected by an electric flaw detector made by the Johns-Manville Co. Flaws in bituminous coatings are caused by chemical decomposition, improper handling, air bubbles, or uncoated spots. This detector is based upon the principle that the instantaneous dielectric strength of asphalt or coal tar enamel is greater than that of air, the coating being subjected for a brief interval to a high voltage electrical stress sufficient to break down very thin spots in the coating or air in pinholes, but not coating of adequate thickness. A spark coil or transformer delivers a voltage of 10,000 to 75,000 volts from a 6-volt storage battery, one pole being connected to the bare pipe or grounded, the other to the detector. One type of detector is in the shape of a ring which surrounds the pipe and is drawn along it at the rate of a slow walk; the other is formed like a brush the bristles of which are a flexible copper screen, with a suitable insulating handle. A flaw is indicated by a sharp crack of the spark as it jumps from electrode to the steel of the pipe. F6-9

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The boldface number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates contruction article; n, note or short article; t, technical article.

A *Journal, American Water Works Ass'n.*
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1. Uniform Marking of Fire Hydrants. Final Report of Committee, pp. 551-556.
2. t. Spectrographic Determination of Minor Chemical Constituents in Various Water Supplies in the United States. By M. M. Braidech, pp. 557-580.

3. Search for Underground Water in Perpetually Frozen Areas. By M. J. Chernyshoff, pp. 581-593.
4. Hydrographic and Meteorological Surveys for Water Supply. By J. E. Jones and G. A. Lewis, pp. 594-599.
5. Elimination of Pits and Subground-Level Pumprooms. By O. E. Brownell, pp. 600-605.
6. Danger of Contamination of Water Supply When Water and Sewer Pipes Are Close Together. By O. E. Brownell, pp. 606-609.
7. Mechanical Cleaning of Water Mains at Evansville. By C. Streithof, pp. 610-612.
8. Water Supply for Construction Camps. By C. C. Elder, pp. 613-626.
9. Corrosion from Zero Softened Waters. By R. L. Derby, pp. 627-630.
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21. Legal Aspect of a Large Artificial Lake Water Supply Project. By C. J. Barber, pp. 755-760.
22. Water Works Records and Their Significance. By G. B. Prindle, pp. 761-766.
23. Specifications for Cast Iron Pipe. Report of Committee A-21, pp. 767-771.

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3. Effects of Reforestation on Water Conservation. By C. P. Birkinbine, pp. 581, 584-585.
4. Soda Ash Solves Color Problem at Peterborough Filtration Plant. By W. G. Hunt, p. 589.
5. Soft Water in Dakota Sandstone Gives Suitable Supply. By J. P. Lawlor, p. 594.
6. Planning the Future of the Distribution System. By C. R. Bird, pp. 597-598.

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7. Soil Erosion Menaces U. S. Future. By M. L. Cooke, pp. 620-623.
8 Effects of Excess Lime Hydrate on Corrosive Soft Water. By F. E. Hale, pp. 624-628.

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7. Chicago Method of Making Chlorine Residual Determinations. By F. F. Donahue and E. Zimbon, pp. 228-229.

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1. Influence of Screen Capacity on Yield of Wells, pp. 1-4.

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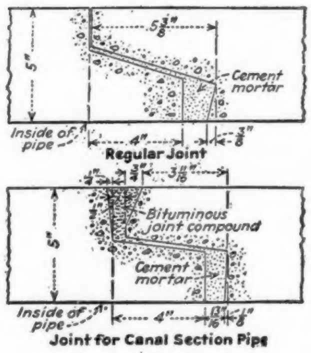
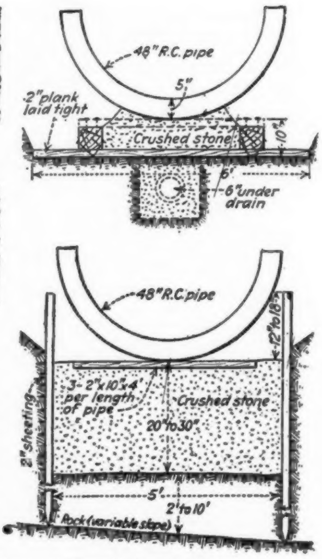
1. History of the Orono-Water System. By J. S. Wise, pp. 44-48.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

SPECIAL pipe foundations were required for 4700 ft. of 48″ concrete pipe in the soft muck of an old canal bed in Cumberland, Md. Solid foundation was 3 to 12 ft. below invert level, rock sloping 60° with the horizontal—too steep for pile supports. At first, pipe was laid on a floor of 2″ plank under which was a 6″ drain surrounded by broken stone; but frost in the soft muck displaced the pipe. The next and successful plan was to drive to rock two lines of wood sheeting 5 ft. part with their tops 12″ to 18″ above invert level; remove the muck for 20″ below such level and replace with crushed stone, and set pipe on 2x10 in. sleepers 4 ft. long, three to a 5 ft. length of pipe, bedded in the stone. Also a special joint was used in this section, the locking joints being kept ½ in. from "home," the vertical faces beveled off, and the space filled with bituminous joint compound.[E7-1]





Above: Concrete pipe joints with bituminous filler applied from the outside are designed to prevent infiltration through the canal section. The regular joint used elsewhere on the pipe line is shown at the top.
At right: Special foundations for the pipe through a stretch of soft ground in the canal bed, where muck overlies a sloping ledge. The top scheme was abandoned after frost got into the subgrade and heaved the pipe.

Pipe joints and foundations at Cumberland, Md.

Malt house wastes can be treated successfully by means of a properly designed, constructed and operated screening and trickling filter system. Studies were made last year by engineers of the Wisconsin State Board of Health at a plant which produced combined pollutional wastes having an average 5-day B.O.D. of approximately 400 ppm, a large part of the pollutional material present being in solution. About 80 gal. of this waste is discharged per bushel of barley processed. From this test it was concluded that "a filter designed on the basis of 50 cu. ft. of filter per pound of 5-day B.O.D. per 24 hrs. and a depth of from 6 to 8 feet can reasonably be expected to produce a 90% reduction in 5-day B.O.D."[C7-13]

Treating slaughter house wastes was studied by the Michigan experimental station which led to the conclusions that (1) "Ferric chloride coagulation when applied to slaughter house wastes gives inconsistent results because it does not have the property of completely coagulating blood proteins. (2) Chlorine treatment if properly applied results in the removal of more than 90% of the B.O.D. and will give consistently good removals. (3) A small amount of ferric chloride added, *after* the chlorine coagulation, aids in settling the floc and concentrating the sludge. (4) Chlorine treatment may be applied successfully at small packing plants as well as at large ones. (5) Chlorine for such treatment is less costly than ferric chloride. Especially so when compared on the basis of purification attained per dollar of cost."

As an illustration of (1), when beef stock was being slaughtered, ferric chloride gave fairly good removals; but when slaughtering hogs, the results were poor regardless of the amount of ferric chloride used.[G7-5]

Concrete destruction by hydrogen sulphide occurred seriously in sewers receiving waste waters from Oklahoma City packing houses; several of the larger ones having fallen in. Chlorine was tried as a preventive but so much of it was absorbed by the organic matter that the cost was prohibitive. Ferrous chloride is now used successfully, as none of it is so absorbed but all goes to converting hydrogen sulphide to ferrous sulphide, which is stable so long as the sewage does not become acid. Also, it is possible to carry a residual of ferrous chloride in the sewage, so that if it should develop hydrogen sulphide or if sewage high in hydrogen sulphide should enter the sewer below the application of the ferrous chloride, there would be sufficient residual of the latter to eliminate any hydrogen sulphide; this permits applying the ferrous chloride at any point in the system of sewers that need protection. In April twelve plants were using this process and several more were preparing to.[C7-9]

Insulating digestion tanks is being studied in England. Consideration was given to hollow walls, slag wool, composite structures, pumice concrete and concrete of cellular structure. It was proposed to line the tank with a 4 in. thickness of cellular concrete, covered with a ½ in. thickness of cement plaster painted with tar; or possibly ¼ in. of bituminous plaster instead of the cement plaster. The roof was insulated with dried peat. Some favored 2 in. of cork set in bitumen, the cost of which was estimated at 36 cts. per sq. ft.[D7-1]

Heating digestion tank is effected in an unusual way in the 50,000 gal. experimental tank operated by the Bury (England) sewage works. This tank is 24 ft. diameter and 39 ft. deep, is provided with a floating roof and Pruss circulator. "A complete circulating and heating system is provided. This consists of a complete hot-water boiler heated with gas obtained from the digestion of the sludge. The sludge is circulated through a coil which is immersed in the heated water. The advantage of this type of heating is that you are not troubled by furring on the pipes as experienced when hot-water pipes are laid in the digestion tanks, and the whole heating system is outside the tank and easily cleaned should necessity arise."

The conclusions reached were all in line with those commonly accepted in this country for a year or more. A possible exception is the opinion (with which possibly some in this country are not in agreement) that the circulator not only prevents scum formation, but "the efficient mixing of the ripe sludge in the tank with the freshly admitted raw sludge rapidly produces evolution of gas and there is a marked increase in two hours after the raw sludge has been admitted."D7-2

Bibliography of Recent Sewerage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

C 7 — *Sewage Works Journal*

May

1. Studies of Sewage Treatment: III—The Clarification of Sewage. By E. J. Theriault, pp. 377-392.
2. *t*, Purification of Sewage by Aeration. By H. Heukelekian, pp. 393-404.
3. *t*, Effect of Varying the Daily Charge of Sewage Solids on the Activated Sludge Process. By H. Heukelekian, pp. 405-416.
4. *t*, Effect of Comminution of Sewage Solids upon Their Subsequent Digestion. By G. M. Fair and E. W. Moore, pp. 417-421.
5. *t*, High and Low Temperature Digestion Experiments: I—Operation and Seeding. By W. Rudolfs and H. J. Mills, pp. 422-434.
6. *t*, A Colorimetric Method for the Determination of Dissolved Oxygen. By M. L. Isaacs, pp. 435-443.
7. *t*, Standard Methods of Sewage Analysis. Report of Committee, pp. 444-491.
8. Sewage Plant Laboratories. By W. Donaldson, pp. 492-505.
9. Treatment of Sewage at Oklahoma City with Iron, Chlorine and Lime. By L. H. Scott, pp. 506-513.
10. Experiments on Settling and Filtering Activated Sludge Aerated Liquors. By S. I. Zack, pp. 514-533.
11. *t*, Measures of Natural Oxidation in Polluted Streams: II—The Reaeration Factor and Oxygen Balance. By H. W. Streeter, pp. 534-552.
12. A National Program for Water Pollution Control. By J. K. Hoskins, pp. 553-563.
13. Malt House Waste Treatment Studies in Wisconsin. By H. W. Ruf, L. F. Warrick and M. S. Nichols, pp. 564-574.

D 7 — *The Surveyor*

May 24

1. Insulation of Separate Sludge Digesters, pp. 645-646.

May 31

2. Sludge Digestion. By Joshua Bolton, pp. 677-679.

E 7 — *Engineering News-Record*

May 30

1. Long Intercepting Sewer Built through Bad Ground (at Cumberland, Md.) pp. 775-777.

June 13

2. Sewer Tunnels Reduce Pollution in Chicago Drainage Canal, pp. 831-835.
3. Salvaged Sewage Filter Stone for Cement Macadam. By Wm. Whipple, pp. 845-847.

June 20

4. Driving Sewer Tunnels through Chicago's Blue Clay, pp. 881-886.

G 7 — *Water Works and Sewerage*

May

1. The Geneva Sewage Treatment Works. By E. R. Wells, pp. 167-168.
2. Chlorinated Iron Solves Odor Nuisance and Improves Digester Performance. By I. R. Riker, pp. 172-174.
3. Effect of Chlorine on Activated Sludge. By W. Rudolfs and I. O. Lacy, pp. 175-177.
4. Sulphates to Sulphides. By C. C. Agar, pp. 189-191.

June

5. Meat Packing Plant Waste Treatment. By E. F. Eldridge, pp. 216-218.
6. Newer Applications of Chlorine in Sewage Treatment. By A. C. Beyer, p. 226.

H 7 — *Municipal Sanitation*

June

1. Chemical-Mechanical Treatment of Sewage. By S. I. Zack, pp. 172-176.
2. N. Y. State Sewage Works Association Meeting, pp. 179-182.

J 7 — *American City*

June

1. Chemical Precipitation of Sewage. By E. W. Steel and P. J. A. Zeller, pp. 48-50.

M 7 — *Canadian Engineer*

May 28

1. Sanitary Engineering Activities of Province of Quebec. By Rene Cyr, pp. 9-12.

June 11

2. Sanitary Situation in Sections of Old Welland Canal, pp. 5-11, 14.

P 7 — *Public Works*

June

1. Comparison of Costs of Treatment Plants, p. 18.
2. Modern Centrifugal Sewage Pumps. By M. M. Klosson, pp. 19-20.
3. A Zooglea-Forming Bacterium Isolated from Activated Sludge. By C. T. Butterfield, pp. 23-26.
4. Eliminating Odors at Sewage Treatment Plants, p. 41.

T 7 — *Technique Sanitaire et Municipale*

May

1. The Actual Status of Sewage Treatment in Russia. By S. N. Stroganoff, pp. 105-109.

What's New?

Disintegrator and Pulperpump:

This unit has been in use in cannery work, disintegrating cannery wastes, which are then run by gravity, or in the case of the Pulperpump, pumped to the sewer line. It reduces gummy or sticky solids without clogging, even large bones, animal carcasses of fairly large size. It is now being tried out in sewage work, where it should find a very useful field; and it should also be of value in breaking down garbage for treatment in sewage tanks.

For a fuller description of this promising unit, write Enterprise Foundry Corporation, 2902-2998 19th St., San Francisco, Calif.

Weed Burners for Highway Work:

At this season of the year when the weed problem is quite an important one, the Littleford weed burner is a handy piece of equipment for the maintenance gang. It can be carried over sloping shoulders and along drainage ditches. Scorch the weeds the first time over and a second application a few days later will destroy them entirely. Burns fuel oil—10, 15 and 20-gallon capacity. Write Littleford Bros., Cincinnati, Ohio, for fuller information on this safe and economical method of weed control.

A New Well Driller:

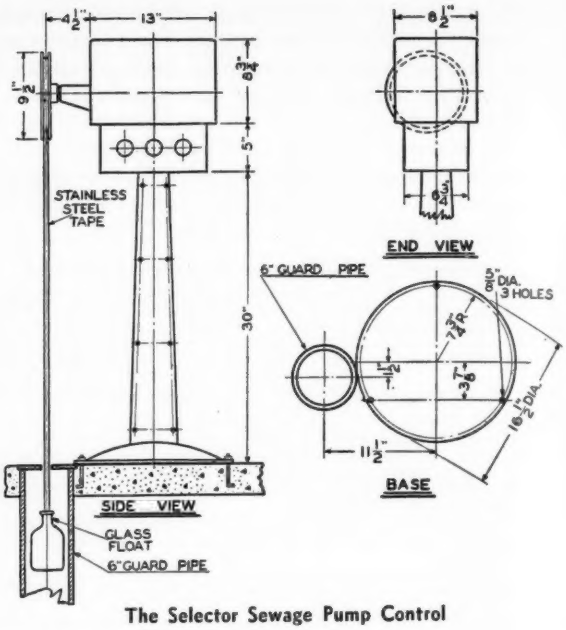
This is a new driller that looks different than most we have seen. It is capable of drilling to 1,500 feet, and starting up to 20-inch holes. Specially suited for water well drilling, but also good for oil and gas work. Weighs 15,000 pounds; can be carried on a motor truck or trail along behind, as 2 or 4-wheel pneumatic tired trailer. Saves time in moving and rigging up. Known as the 29-W Bucyrus-Armstrong, it is manufactured by Bucyrus-Erie Co., South Milwaukee, Wisc.

Selector Sewage Pump Control:

This is a float actuated electric switching system for starting and stopping pump motors in sequence. Where several pumps of different capacities are employed, it will cut in or out the pumps in proper sequence to provide the required capacities consistent with the inflow into the tank.

A single instrument, with one float, is used for any number of pumps or speed variations. It is readily adjustable for any desired sequence or length of time of pump operation, and also for any desired level of the sump. A variation of this type will maintain any desired level in elevated tanks.

It is manufactured by the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Full information and data sent on request.



The Selector Sewage Pump Control

Centrifugal Pumps:

The Lawrence Machine & Pump Corp., 371 Market Street, Lawrence, Mass., has issued Bulletin 201, covering their double suction, horizontally split pumps. It describes the construction of pumps of this type, their applications, and indicates the range of capacities and heads for the different sizes. It has several excellent installation views, and cuts showing details of construction and the overall dimensions for the different sizes.

Dust Must Go:

An ingenious folder in which a truck loaded with calcium chloride moves across a dust covered landscape, when the folder is opened, and eliminates the dust. Cute to work, and the text offers sound information on dust control. Write Dow Chemical Co., Midland, Mich.

Processed Kyrock:

A new bulletin on Kentucky Rock asphalt is available. This contains lots of information for the highway engineer, and tells of the construction types of highways available with this material. Stated to be non-skid in highest degree. Processed Kyrock is much cheaper than natural Kyrock, Kentucky Rock Asphalt Co., Louisville, Ky.

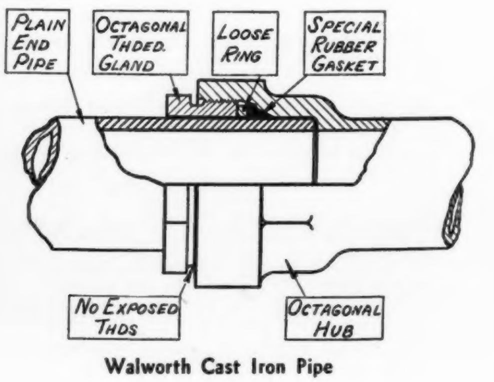
Signs:

"DANGER" and other signs — all sizes and varieties, are shown in a bulletin issued Mine Safety Appliance Co., Pittsburgh, Pa.

A New Hi-Test Cast Iron Pipe:

This new pipe is furnished in sizes from 1¼ to 6-inch, in 20-ft. lengths, with threaded joints, but it also can be supplied in 5, 10 and 15-foot lengths. It is suitable for working pressures up to 175 pounds per square inch, and was developed especially for uses under difficult service conditions. If requested, each length can be tested hydrostatically up to 500 pounds per sq. in. Close tolerances are a feature. Write the Walworth Co., 60 East 42nd St., N. Y., for detail information.

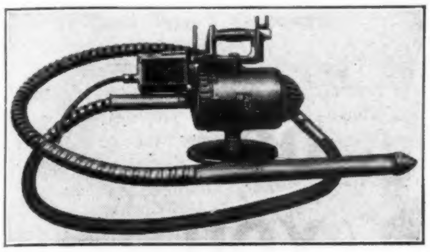
Bucyrus-Armstrong Well Driller



Walworth Cast Iron Pipe

Mall Vibrator Unit:

A concrete vibrator unit with either a 2⅜" or 3¼" diameter vibrator powered with a new type 3 hp. 3 phase totally enclosed dust and vapor proof motor has been introduced by the Mall Tool Company, Chicago, Illinois. The machine can be used under the most adverse conditions which prevail on the job. Switch and motor are fully protected against burnouts. The machine is light weight and portable and is easily moved from one location to another. Can be furnished with fourteen feet, twenty-one feet, or

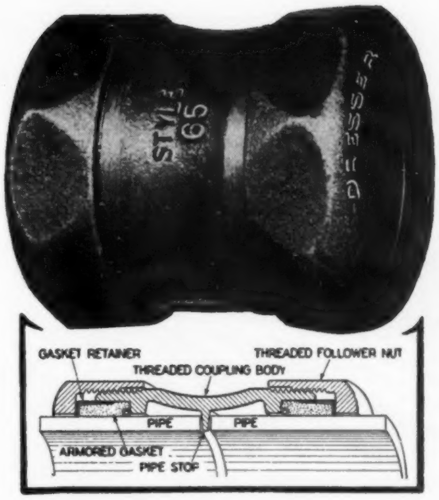


New Vibrater Unit by Mall

twenty-eight feet of flexible shafting, depending upon the depth of the forms; also attachments for concrete rubbing, grinding, drilling, and sawing. Bulletin on request.

Speedy Speeder Tractor Shovel:

The features of this Speeder tractor shovel include as great mobility as a Caterpillar tractor. It will travel at speeds up to nearly 5 miles an hour under its own power, and will negotiate heavy grades, ditches and soft ground as well as a tractor. It is said to be very fast in operation. It has the Speeder patented crowd for shovel operation; anti-friction bearings; very simple and strong construction; and easy one-man operation. Shovel boom length is 14 feet and dipper stick 11 feet. Crane and dragline booms are 22 feet. For specifications and details write Edgar McNall, Speeder Machinery Corp., 1201 South Sixth Street, West, Cedar Rapids, Iowa.



Dresser Style 65 Coupling

New Coupling Simplifies Joint Making

Several unusual features are incorporated in a new, self-contained pipe joint just announced by the S. R. Dresser Manufacturing Company of Bradford, Pennsylvania. To make a connection with this new joint, the Dresser Style 65 Compression Coupling, nothing is needed except the pipe (plain end), the joint itself and an ordinary wrench. Making the joint simply involves inserting the pipe ends into the coupling (which comes assembled) and then tightening two threaded octagonal nuts—the whole operation taking only a few seconds.

As the nuts are tightened, two resilient "armored" gaskets are compressed tightly around the pipe, gripping it with tremendous force and giving a positive seal.

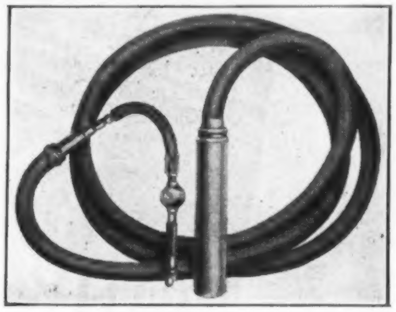
The resulting joint is not only permanently tight but absorbs normal vibration, expansion and contraction movements, and permits deflections of the pipe in the joint.

Other advantages are these: the pipe need not be cut to exact lengths; joint making in cramped quarters is simplified; repairs on old lines can be quickly and easily made; and the joint is suitable for exposed lines because of its compact appearance.

These Compression Couplings are supplied, black or galvanized, in standard steel pipe sizes from ⅜" I.D. to 2" I.D. inclusive.

The Shimmy Spade:

This is an air-powered vibrator for concrete placement. It is said to be compact, handy, watertight; the air motor is attached directly to the rotary eccen-



The Shimmy Spade

tric, thus eliminating the flexible shaft. High in speed, and with few moving parts. It is manufactured by the Chicago Pneumatic Tool Co., 6 East 44th Street, New York, N. Y. A description will be sent on request.

New Light Weight, Portable Pump:

A new portable, self-priming, centrifugal 3" pump is being made by the Homelite Corporation of Port Chester, N. Y. It weighs only 88 pounds complete with a built-in, air-cooled gasoline engine. This pump handles 15,000 gallons per hour and has a guaranteed suction lift of 28 feet. It is built to handle muddy water with solids.

The main parts of this pump, such as pump body, crank case and end plate are made of a special abrasion-resistant aluminum alloy that weighs only 1/3 as much as cast iron.

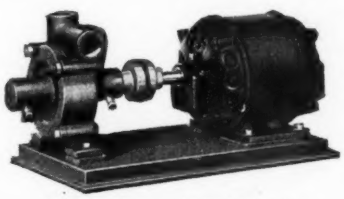
For fuller data, write the Homelite Corporation, 78 Riverside Avenue, Port Chester, N. Y.

Speedster Mobile Power Shovel

Homelite Portable Pump at work

Turbine Pumps for High Heads:

For use in all industries or installations where small quantities of liquid are to be pumped against high heads, a new pump, Type T, has been developed by Roots - Connersville - Wilbraham, Con-



Roots Type T Centrifugal

nersville, Ind. The advantages of this type of pump include a high vacuum, only one moving part, a balanced impeller and no metal-to-metal contact. Pump speeds are suited to direct drive from electric motors.

The turbine pump combines positive and centrifugal characteristics. They have an average suction lift of 25 feet, it is claimed. Capacities are from 20 to 300 gallons per minute.

A New Backfill Scraper

The Newo Hoist Company, 17309 Fernway Road, Cleveland, Ohio, has just announced a new type backfill scraper, heavier and more rigid than the conventional type scraper. It is claimed by the manufacturer that this scraper will dig much harder material due to the fact that the cutting edge strikes the material first and there are no side bars or braces to keep the cutting edge from entering the material.

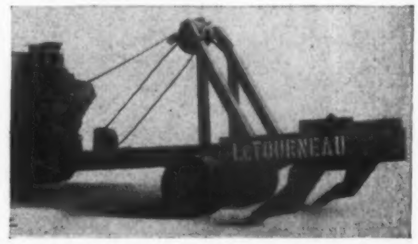
Quick change is made possible by the use of rope sockets. These boards are built in widths of three to twelve feet to fit all makes of cranes. Fuller data on request.

Tying Concrete
Rooting
Loading
Pumping
Backfilling

The Barber-Greene Model 82 Bucket Loader

3 Yards in 45 Seconds With New Bucket Loader:

The illustration herewith shows the external features of a new bucket-type loader just announced by Barber-Greene Co. An improved frame, synchronized feeding and a knee-action axle are some of the features, which include also closely-spaced buckets, hard-faced bucket lips, fast travel speeds, slow crowding speeds, etc. It has done 3 yards in 45 seconds. For fuller details write Jack Turner, Barber-Greene Co., Aurora, Ill.



The Le Tourneau Rooter

LeTourneau Rooter For 35 and 50 Tractors

To fill the demand for a rooter that may be used with 35 and 50 horsepower tractors, R. G. Le Tourneau, Inc., is now manufacturing the Type S Rooter.

The same rugged, all-welded, special steel construction that goes into the larger Le Tourneau Rooters is used in this smaller size. In general, it follows the same design, but is lightened somewhat to assure efficient use with tractors from 35 to 50 horsepower.

It will handle much of the ripping and scarifying usually handled by larger rooters, and so free large tractors for heavier work. Demonstrations on Forestry Service work proved the new unit to be very satisfactory. Write R. G. Le Tourneau, Stockton, Calif., for further data.

To Tie New Concrete to Old:

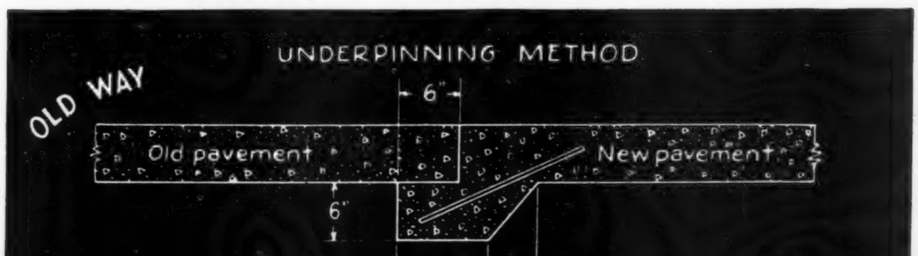
An entirely new method of securely tying new concrete to old has been developed by J. Warren Isett, president of the American Expansion Bolt & Mfg. Co., 108-128 North Jefferson St., Chicago, Ill.

The method consists of drilling a series of holes about 4¼ inches deep into the old concrete. Into these holes are placed ⅝ or ¾-inch expansion anchors, with 180° or 90° bend. The usual length of these anchors is 11 inches, but they may be shorter or longer. Rods, mesh or mat reinforcement—whichever is being used—are then attached to these anchors and the concrete poured.

Tests show that these anchors have a holding power in excess of 8500 pounds each. The cost of this method is very small—much less than other usual methods.

This method of tying new concrete to old is especially adapted to all municipal engineering work, and can be used with equal facility and economy in fastening together new and old slabs in highway widening, repair and resurfacing, and in water, sewage treatment and other tanks. In such work they are of value in tying old concrete walls to new to get a tight and solid connection, and in fastening together the concrete at construction and other joints on new work.

Full information will be sent on request to Mr. Isett.



New and old ways of tying pavement slabs together